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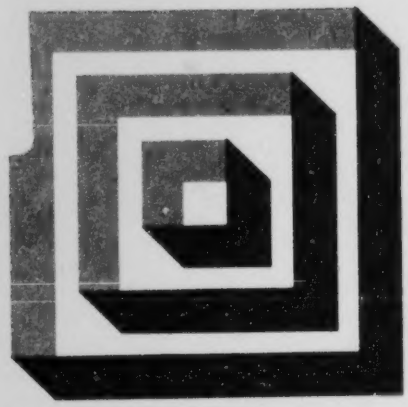
ABSTRACT

Effective planning and rationalization of long-term graduate development in Ontario's universities concerning solid earth sciences are discussed in relation to a report and recommendations of the Council of Ontario Universities and a report of the Advisory Committee on Academic Planning. Recommendations suggest: (1) The universities proceed with their plans on the basis of modest growth, using the consultants' minima as probable figures. (2) Admissions policies continue to be based on academic standards with an adequate level of financial support for each student. (3) In all general scholarship schemes the Government of Ontario, the National Research Council, and the universities of Ontario provide for a percentage of the awards available. (4) Continued and increased emphasis be placed on applied specialities. (5) No new program in geophysics be started in the next 5 years. (6) Departments and the discipline groups consider greater emphasis on limnology, marine geology, applied environmental geology, and geophysical techniques. (7) Carleton University and the University of Ottawa consider some formalization of the existing cooperative aspects of the work of their geology departments. (8) Brock University continue its master's program in quaternary geology in accordance with its stated plans. Eleven additional recommendations are presented, each concerning programs at various Canadian Universities. (MJM)

Council of Ontario Universities

Perspectives and Plans for Graduate Studies



6 Solid Earth Science 1973

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NATIONAL INSTITUTE OF
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Advisory Committee on Academic Planning
Ontario Council on Graduate Studies

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Council of Ontario Universities
Conseil des Universités de l'Ontario

PERSPECTIVES AND PLANS

FOR GRADUATE STUDIES

6. Solid Earth Science 1973*

Advisory Committee on Academic Planning
Ontario Council on Graduate Studies

74-6

* The status of this report is given in Item 2 of the statement of principles, on page 1.

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TABLE OF CONTENTS

		Page
FOREWORD		i-ii
REPORT AND RECOMMENDATIONS OF THE COUNCIL OF ONTARIO UNIVERSITIES		1-6
REPORT OF ADVISORY COMMITTEE ON ACADEMIC PLANNING		1-20
APPENDICES		
Appendix A:	Report of Consultants	A1-A62
Appendix B:	Responses of Discipline Groups	B1-B13
Appendix C:	Comments by Universities	C1-C42
Appendix D:	Procedure of Planning Study and Terms of Reference	D1-D5
Appendix E:	Membership of Discipline Groups	E1-E2
Appendix F:	Future Roles of ACAP and of Discipline Groups	F1-F5
Appendix G:	Curricula Vitarum of the Consultants	G1-G4

FOREWORD

The Advisory Committee on Academic Planning (ACAP), as presently constituted, was established by the Ontario Council on Graduate Studies at the request of the Council of Ontario Universities in January, 1971. The Advisory Committee's terms of reference were directed broadly toward the effective planning and rationalization of long-term graduate development in Ontario's universities both at the level of individual disciplines and at a more general level. The Advisory Committee's activities are based on the premise that graduate work is the one area of university activity in which specialization among universities, cooperative arrangements and comprehensive planning are most necessary.

In March, 1971, concern over the rising costs for support of graduate work prompted the Ontario government to institute a general embargo on funding for any new graduate programme, that is, one which had no students enrolled on May 1, 1971. This embargo was subsequently modified to include only those disciplines in which over-expansion was felt to be potentially most serious. ACAP was to begin immediately planning studies in those disciplines which remained embargoed.

The disciplinary planning process begins with the formation of a discipline group composed of one representative from each university with an interest in graduate work in the planning area. The discipline group assists in defining the precise academic boundaries of each study, scrutinizes the data collection forms, prepares a list of potential consultants, maintains contact with the consultants during the study, and prepares a commentary on the consultants' report.

The final decision on consultants for the planning study is made by ACAP. The consultants are requested to make recommendations on programmes to be offered in Ontario, desirable and/or likely enrolments, the division of responsibility for programmes among universities, and the desirable extent of collaboration with related disciplines.

While the consultants' report is the single largest element in the final report on the planning study, ACAP considers the statement of each university's forward plans to be most significant. These forward plans are usually outlined prior to the planning study, and are used as a basis for comments from the universities concerned on the consultants' report.

On receipt of the consultants' report, and comments on it from the discipline group and the universities, ACAP begins work on its own recommendations for submission directly to the Council of Ontario Universities. COU considers the input from all sources, and prepares the position of the Ontario university community.

The following report is one of a series of disciplinary planning studies carried out by the Advisory Committee on Academic Planning and to be published by the Council of Ontario Universities. The emphasis of the report is on forward planning, and it is hoped that the implementation of COU's recommendations will help to ensure the more ordered growth and development of graduate studies in Ontario's universities.

* * * * *

Council of Ontario Universities
Conseil des Universités de l'Ontario

Report and Recommendations Concerning Graduate Studies in Solid Earth Science

On the instruction of the Council of Ontario Universities, the Advisory Committee on Academic Planning has conducted a planning assessment for solid earth science. The resultant report from ACAP is attached, together with the consultants' report, the comments by the Discipline Groups, and the comments of the individual universities. The procedures followed and the planning techniques used are described in the ACAP report and are not repeated here. It is important for the reader to read the ACAP report and attachments in order to understand the recommendations in this Report from COU.

This report deals with all aspects of solid earth science including geomorphology, geology and geophysics.

The Council received the ACAP report and supporting documentation on March 1, 1974. The contents of the document were debated on that date and on April 11. As a result of these discussions this Report and Recommendations were prepared and approved by the Council on April 11, 1974. The Report is addressed to the Committee on University Affairs and the universities of Ontario.

The following principles have been adopted and will apply to this and all other COU Reports arising out of assessments.

1. Discipline assessments by ACAP should form the basis for planning by the universities of their development of graduate studies, particularly PhD programmes. On the basis of these assessments, COU should make its own recommendations on currently embargoed programmes. Each university must retain the freedom and responsibility to plan and implement its own academic development. However, the universities, in embarking on a co-operative planning process have signalled their intentions of cooperating with the COU recommendations.

2. Universities generally plan their emphases in graduate study on the bases of related departments, not of single departments. Initially, the sequential nature of the discipline planning assessments makes this difficult. However, by the Summer of 1974 there will have been assessments of most of the social sciences, all of the physical sciences, engineering doctoral work, and a number of professional areas. On the information and recommendations then available, each university should be able to make decisions concerning its support of graduate programmes in these areas. Amendments to university responses to the individual discipline planning assessments may then be made in the wider context of a group of related disciplines and amendments to COU's original Reports on an individual discipline may be required.

3. The first concern in planning is to review the quality of graduate opportunities and of students in Ontario universities and to make judgments about how to proceed or not proceed based on quality considerations. The procedures have made use of highly-qualified independent

consultants who have no direct interest in the universities in Ontario. Accordingly, COU feels bound to accept their judgments about quality where they are stated clearly unless unconvinced that their conclusions about quality are consistent with their evidence. COU's recommendations in the case of programmes which are of unsatisfactory or questionable quality will call for discontinuation or the carrying out of an appraisal, if the continuation of the programme is not crucial to the province's offerings. In some cases, however, there may be a particular need for the programme and the appropriate recommendation will be to strengthen it, with an appraisal following that action. It is also possible that if there were found to be too large a number of broadly-based programmes there could be a recommendation to discontinue the weakest; in this case, an appraisal for a more limited programme might be relevant.

4. A second consideration is the scope of opportunities for graduate work in the discipline. Do the Ontario programmes together offer a satisfactory coverage of the main divisions of the discipline?

5. Numbers of students to be planned for will depend on the likely number of applicants of high quality and in some cases may relate to an estimate of society's needs. Such estimates may be reasonably reliable in some cases and not in others. If the plans of the universities appear to be consistent with the likely number of well-qualified applicants and there is either no satisfactory basis for estimating needs or there is no inconsistency between a reasonable estimate of need and the universities' plans, then COU will take note of the facts without making recommendations on the subject of numbers.

If the numbers being planned for by the universities are grossly out of line with the anticipated total of well-qualified students, or a reliable estimate of needs, COU will make appropriate corrective recommendations. Depending on the circumstances, these may call for a change in the total numbers to be planned for and indications of which institutions should increase, decrease, or discontinue. The recommendations in serious cases may need to specify departmental figures for each university for a time. If the numbers being planned for are insufficient, the recommendations may call for expansion, or new programmes, and may have implications for both operating and capital costs.

Unless there are exceptional circumstances, the recommendations concerning enrolment will not call for a university to refuse admission to any well-qualified student who wishes to work in a field in which that university offers a programme and in which it has the capacity to accommodate the student.

6. The quality of graduate programmes is partly dependent on size, and for each programme, depending on how it is designed and its scope, there is a minimum size of enrolment below which quality may suffer. That number cannot be expressed for the discipline as a whole but only for individual programmes depending on their purpose, their resources and their design.

7. Universities will be expected to notify COU if they intend to depart from the COU Report in any way which they believe might have a significant bearing on the provincial plans.

8. Appraisals arising as the result of assessments are to be based on the standards but not necessarily the scope of the acceptable programmes in the province.

General observations concerning solid earth science

1. Most fields of solid earth science are covered adequately by the programmes offered in the province but there is a need for more emphasis on limnology, marine geology, applied environmental geology and geophysical techniques. Applied specialties also need more attention in the province's departments.

2. The universities' plans for the level of future enrolment are consistent with the consultants' suggested minimal figures. The energy crisis and its possible effects on graduate enrolments in solid earth science introduce a measure of uncertainty into future enrolment planning, and suggest the particular importance of regular review by the Discipline Groups and ACAP.

3. Except for the new doctoral programmes recommended below, no other doctoral programmes will be needed in the next five years. The only possible exceptions to this might be a new doctoral programme in geophysics, if the enrolment grows to justify it, and the addition of a major field (geomorphology) to the Guelph doctoral programme.

Recommendations

It is recommended that:

1. The universities proceed with their plans on the basis of modest growth, using the consultants' minima as probable figures, but be prepared to respond to demand beyond these levels.

	1977-78	1982-83
Total	510	620
Master's	306	370
Doctoral	204	250

2. Admissions policies continue to be based on academic standards with an adequate level of financial support for each student. Of course, the number of students admitted to a department is also bounded by and subject to the capacity of the department to accommodate students.

3. In all general scholarship schemes, the Government of Ontario, the National Research Council, and the universities of Ontario provide for a percentage of the awards to be open to able, well-qualified graduate students from abroad in competition with Canadian applicants.

4. Continued and increased emphasis be placed on applied specialties.

5. Except as noted below no new programme in geophysics be started in the next five years.

6. Departments and the Discipline Groups consider greater emphasis on limnology, marine geology, applied environmental geology and geophysical techniques.

7. Carleton University and the University of Ottawa consider some formalization of the existing cooperative aspects of the work of their geology departments, and inform COU of the results.

8. Brock University continue its master's programme in quaternary geology in accordance with its stated plans.

9. Carleton University continue its master's and doctoral programmes in geology in collaboration with the University of Ottawa, and its master's programme in physical geography according to its plans.

10. The University of Guelph continue its master's and doctoral programmes in soil science and master's work in geomorphology in the Geography Department. The desirability of extending the scope of the doctoral programme should be a matter for recommendation by ACAP when the University has a detailed proposal.

11. Laurentian University continue its master's programme in geology, but also submit it for appraisal. Consideration should be given, if the appraisal should be negative, to the alternative of strengthening rather than closing the programme. If a favourable appraisal has not been obtained by January 1, 1976, the enrolment of new students should be suspended.

12. McMaster University continue its master's and doctoral programmes in geology and its master's and doctoral programmes in physical geography according to its plans.

13. The University of Ottawa continue its master's and doctoral programmes both in geology and in geomorphology in the Geography Department, on the assumption that cooperation with Carleton will continue in geology and between geology and geography internally.

14. Queen's University's master's and doctoral work in geology and master's work in physical geography continue as planned. It is recommended that the Geography Department commence to offer its doctoral programme in geomorphology and pedology.

15. The University of Toronto continue its programmes for master's and doctoral work in geology, physical geography and geophysics in accordance with its plans.

16. The University of Waterloo continue its master's programme in earth science and also its new doctoral programme in environmental geology, specializing at both levels in groundwater geology and engineering geology as appraised.

17. The University of Western Ontario continue its master's and doctoral programmes in the Departments of Geophysics and Geology (including the geomorphology programme within the Geology Department) and also the graduate work in pedology in the Geography Department, all as planned.

18. The University of Windsor continue its master's programme in geology and that it submit its master's programme in physical geography for appraisal with the understanding that it cease to accept new students as of January 1, 1975, if a favourable appraisal has not been obtained by that date.

19. In view of the acceptance of these recommendations by COU and the completion of this planning assessment, CUA request the Minister to remove the embargo on solid earth science (including geomorphology) in accordance with the original announcement of the Minister that new graduate programmes would be embargoed until, for each discipline, a planning study has been conducted.

Notes concerning the recommendations

Re: Recommendation 5

Any moderate increase in enrolment in geophysics could be handled easily by the existing two departments. Should there be a substantial increase in the interest in this field, plans from any interested university to mount a third programme should be submitted to ACAP.

Re: Recommendation 8

COU is preparing a study proposal in this area.

Re: Recommendation 11

The documentation on Laurentian's 5-year plan for graduate work contains a proposal for an interdisciplinary earth sciences MSc. This as a new programme would require appraisal. If in the course of developing its 5-year plan, the University were to decide to continue the present geology programme, it too would require an appraisal. Sufficient time (January, 1976) has been provided to allow Laurentian to prepare for appraisal.

Re: ACAP Recommendation C9

An ACAP recommendation concerning support for research in the absence of graduate students and funding for postdoctoral fellows is no reflected in the COU recommendations because the problem is general to many disciplines, and is already under study by COU.

April 11, 1974

ADVISORY COMMITTEE ON ACADEMIC PLANNING

ONTARIO COUNCIL ON GRADUATE STUDIES

REPORT TO THE COUNCIL OF ONTARIO UNIVERSITIES

ON

SOLID EARTH SCIENCE PLANNING ASSESSMENT

March 15, 1974

RECOMMENDATIONS

C1:

It is recommended that the universities plan on the basis of modest growth, using the consultants' minima as probable figures.

	1977-78	1982-83
Total	510	620
Master's	306	370
Doctoral	204	250

C2:

It is recommended that admissions policies continue to be based on academic standards with an adequate level of financial support for each student. Of course, the number of students admitted to a department is also bounded by the capacity of the department to accommodate students, a capacity which will have been planned in accordance with Recommendation C1.

C3:

It is recommended to the Government of Ontario, the National Research Council and the universities of Ontario that all general scholarship schemes provide for a percentage of the awards to be open to able, well-qualified graduate students from abroad in competition with Canadian applicants.

C4:

It is recommended that continued and increased emphasis be placed on applied specialties.

C5:

It is recommended that except as noted below no new programme in geophysics be started in the next five years.

C6:

It is recommended that departments and the Discipline Groups consider the consultants' view that greater emphasis should be placed on limnology, marine geology, applied environmental geology and geophysical techniques.

C7:

It is recommended that Carleton University and the University of Ottawa consider some formalization of the existing cooperative aspects of the work of their geology departments, and inform COU of the results.

C8:

It is recommended that no new doctoral programmes, other than those recommended in this report, be considered for commencement during the period 1977-78.

C9:

It is recommended that urgent attention be given to the question of research funding for professors whose departments do not offer graduate programmes in their fields, and also that post-doctoral fellows be given a B.I.U. weight.

C10:

It is recommended that Brock University continue its master's programme in quaternary geology in accordance with its stated plans.

C11:

It is recommended that Carleton University continue its master's and doctoral programmes in geology in collaboration with the University of Ottawa, and its master's programme in physical geography according to its plans.

C12:

It is recommended that the University of Guelph continue its master's and doctoral programmes in soil science and master's work in geomorphology in the Geography Department. The desirability of extending the scope of the doctoral programme should be a matter for recommendation by ACAP when the University has a detailed proposal.

C13:

It is recommended that Laurentian University continue its master's programme in geology, but also submit it for appraisal. Since there are arguments in favour of a geology master's programme in Sudbury, consideration should be given, if the appraisal should be negative, to the alternative of strengthening rather than closing the programme. If a favourable appraisal has not been obtained by January 1, 1976, the enrolment of new students should be suspended.

C14:

It is recommended that McMaster University continue its master's and doctoral programmes in geology and its master's and doctoral programmes in physical geography according to its plans.

C15:

It is recommended that the University of Ottawa continue its master's and doctoral programmes both in geology and in geomorphology in the Geography Department, on the assumption that cooperation with Carleton will continue in geology and between geology and geography internally.

C16:

It is recommended that Queen's University's master's and doctoral work in geology and master's work in physical geography continue as planned. It is recommended that the Geography Department commence to offer its doctoral programme in geomorphology and pedology.

C17:

It is recommended that the University of Toronto continue its programmes for master's and doctoral work in geology, physical geography and geophysics in accordance with its plans.

C18:

It is recommended that the University of Waterloo continue its master's programme in earth sciences and also its new doctoral programme in environmental geology, specializing at both levels in groundwater geology and engineering geology as appraised.

C19:

It is recommended that the University of Western Ontario continue its master's and doctoral programmes in the Departments of Geophysics and Geology (including the geomorphology programme within the Geology Department) and also the graduate work in pedology in the Geography Department.

C20:

It is recommended that the University of Windsor continue its master's programme in geology and that it submit its master's programme in physical geography for appraisal with the understanding that it cease to accept new students as of January 1, 1975, if a favourable appraisal has not been obtained by that date.

C21:

It is recommended that COU adopt the recommendations of this report, and, in the expectation that its members will act in accordance with them, COU inform CUA that it has adopted these recommendations and request that the embargo on solid earth sciences (including geomorphology and pedology) be now removed, in accordance with the original announcement of the Minister that new graduate programmes would be embargoed until, for each discipline, a planning study had been conducted.

PROCEDURE

On the advice of the Ontario Council on Graduate Studies, the Council of Ontario Universities, on September 17, 1971, instructed the Advisory Committee on Academic Planning to conduct a formal planning assessment for the earth sciences.

This assessment differs from the previous ones in that it is an effort to combine closely related disciplines in one study. Most of the earlier assessments were done on what are departments in a university, for example, chemistry and economics. This assessment of solid earth sciences includes geology, geomorphology and geophysics. The related departments would include geology, geography, geophysics, physics, chemistry and some engineering. As can be seen, this meant a more complicated collection of data for the universities, making sure all departments that dealt in solid earth sciences reported.

Since there has recently been some renewed discussion concerning the desirable scope of planning studies it may be useful to note that originally ACAP suggested that there be just two planning assessments in a large area of related studies, viz geography, other earth sciences, urban and regional planning and related environmental studies. One assessment was proposed to cover the more physical science side (geology, parts of geography and geophysics) and the other assessment would deal with the remainder. There was considerable opposition from the Geography Discipline Group to the proposal that there be no separate geography assessment, and after further discussion with the three discipline groups involved, it was decided to have three planning assessments, one in geography (except for geomorphology and pedology) and involving only the Geography Discipline Group, one in solid earth sciences involving the Geography Discipline Group and the Geology Discipline Group (with some geophysicists in attendance), and one in planning and environmental studies involving the Discipline Group of that name and also with comments from the Geography Discipline Group.

Both the geography and geology Discipline Groups are made up of members named by each interested university. The membership of these groups is attached as Appendix E. The ACAP geography portfolio, previously held by Professor R.F. White is now held by Professor G. Setterfield and Dean A. D'Iorio holds the geology portfolio. A 'portfolio holder' takes particular interest in that discipline and sometimes, when ACAP representation is necessary, attends meetings of the discipline groups.

The procedure and terms of reference for the planning assessment were approved by OCGS and COU, the latter's approval being received on February 4, 1972. This document is attached as Appendix D.

The Geology Discipline Group began its meetings in December 1971, and the Geography Discipline Group, early in 1972. In accordance with the procedure, the Discipline Groups provided ACAP with lists of possible consultants. ACAP obtained the services of Professor F.A. Campbell, University of Calgary, Professor G. Dury, University of Wisconsin, Professor R.D. Russell, University of British Columbia and Professor M.J. Dunbar, McGill University. Brief curricula vitarum appear as Appendix G. Dr. Dunbar played the role of the senior Canadian academic from outside the discipline of solid earth science. The consultants held their first meeting in Toronto in June, 1972, and also met with the Discipline Groups to discuss any general questions the Groups wished to raise and also to discuss the schedule and format of their visits to the universities. These began in August and continued through October.

A draft report of recommendations was presented to the Discipline Groups for informal comments on February 24, 1973, and a final report was subsequently received and distributed March 19, 1973. The Discipline Groups and the universities were requested to submit comments to ACAP by April 19, 1973. After receipt of these comments, a subcommittee of four ACAP members met to draft the ACAP recommendations. This subcommittee, after careful reading of the report and the comments from the Discipline Groups and the universities, felt it would be impossible to formulate recommendations for COU without additional input from the consultants. Accordingly, ACAP requested the consultants to revise their report. This revised edition was mailed to the Discipline Groups and universities for comment October 15, 1973. University comments were due November 30 and the Discipline Groups' comments, December 14, 1973. These comments appear as Appendix C and Appendix B respectively. Only those comments specified by each university for publication are included in Appendix C.

This report, then, is based on these revised data, reports and comments, and sets out recommendations for COU on the plan for graduate work in solid earth sciences in the province for the next several years.

As is required, ACAP presents this report directly to COU. It has been transmitted as well to the Ontario Council on Graduate Studies and the Council of Deans of Arts and Science for information.

Despite its revision, the consultants' report does not contain as full a discussion as one would wish of the current strengths and weaknesses of the several departments whose future development it considers. Nevertheless, it gives considerable information and certainly constitutes an acceptable base for many planning decisions. In its comments, the Geology Discipline Group recommends against publication of the consultants' report. It is really impractical to suggest the suppression of a report that has been accepted by ACAP as adequately fulfilling the terms of reference of consultants. Nevertheless, it may be helpful for us to comment further on ACAP's consideration of this suggestion.

We noted that the acerbity of the Discipline Group's comments is not found in the comments of the Geography Discipline Group nor in those of the universities. The Geology Discipline Group gives several reasons for rejecting the report. One is the "lack of information about the present states of Departments"; we do not believe much has changed significantly during the last year, certainly not in teaching personnel or departmental funds. The Group notes "the lack of revised and accurate graduate enrolment figures"; we assume they refer to 1972-73 and 1973-74 enrolments and we remark that these have been of value to ACAP in preparing its report but hardly affect the arguments in the consultants' report. "The lack of reference to research of particular importance to one Department within the system" is a reference we do not understand, but such an omission is at worst an inadequacy and it may well be irrelevant to any recommendations. We are also puzzled by the references to the lack of discussion with "Government and other agencies". The terms of reference of the consultants make it clear that discussions might be held with any group if the consultants felt they would be helpful in carrying out their task. The consultants were equally free to decide that they had sufficient background on likely developments in earth sciences without such discussions; they had available, for example, the Science Council Study of 1971 to which the Discipline Group refers. It was not their task to duplicate this work, but rather to apply it and similar background studies and their own knowledge of their disciplines to recommending on the development of graduate work in Ontario. This limited objective is very different from that of advising on the selection of the most productive future thrusts of the research activities in a discipline. It is therefore inappropriate to compare this report with that of the Science Council or the similar United Kingdom report which the University of Western Ontario commends; these reports had very different purposes and would serve as 'data' for our consultants. (The U.K. report, on a rapid examination, does not seem to deal at all with graduate education per se.)

As with all our reports, it is valuable to read the comments of the universities and the Discipline Groups as well as the ACAP report and the consultants' report.

The university comments on the consultants' report range from "general satisfaction", "much more acceptable than the earlier version", and "generally acceptable" to "disappointed in the quality of the report", and "an essentially superficial, hurried report". There appears to be general agreement with the tenor of the recommendations and there is expressed unanimous agreement with the recommendations on admissions. Several of the universities fault the consultants for lack of detailed discussion of certain of the subdisciplines of their own campuses, such as geomorphology, geotechnique and, to a lesser extent, precambrian geology. Only one university appears to disagree in a fundamental way with the picture of it presented by the consultants.

Before this report there had been no external validation of the standard of graduate work in Ontario earth science departments in general, nor any examination of growth potential. That an examination of this kind was

needed is indicated by the uncertainty of universities in planning development in this area of study and by the decision of the government a few years ago not to provide funds for proposed new geology buildings. The consultants' report justifies general confidence in recommendations calling for growth in this area of study, since both the case for need and the adequacy of the academic standards have withstood external validation.

It is not normal ACAP practice to include in its report an opinion of the quality of the consultants' report but it seems necessary in this case to summarize the above by saying that although we do not find this report amongst our most complete ones, it certainly is acceptable, and does not appear to us to do a disservice to geology as the Discipline Group suggests.

GENERAL INTRODUCTION

Planning Techniques

For some years now, the universities of Ontario have been committed to the belief that the quality and effectiveness of graduate study in the province can be ensured only by collective and cooperative action. This implies a mechanism for continuing consultation and agreement so that the plans of each university for each of its disciplines are concerted with those of the other universities. At any given time there will exist a plan for the development of each discipline, with agreed and understood roles for each department; since graduate education is the most advanced formal intellectual activity and is, therefore, undergoing change, it is necessary that such plans be kept under regular review and be subject to ready amendment.

The Council of Ontario Universities had assigned to the Ontario Council on Graduate Studies the task of advising it on the development of such plans and of the steps to be taken to carry them into effect. The Standing Committee which carries out these tasks for OCGS is the Advisory Committee on Academic Planning. A significant role is also played by the discipline groups, one of which is established for each subject, with a representative from each interested university. Each discipline group has the function of assisting and advising ACAP in connection with its own subject.

The above may give the impression that the planning activity is fragmented on a disciplinary basis. This would, of course, not be acceptable. Since the development of one department in a university should not be considered independently of its contribution to the rest of its university and of the influence of the university as a whole on the department, it is most important the universities as institutions play a central role in the planning process. One of the most effective ways of doing this is by indicating to ACAP the nature of institutional commitments to a department and institutional aspirations for the department.

The most significant single input to a planning assessment is the set of statements from each university of its plans for its department. When these are subjected to collective scrutiny it may be found that their totality constitutes a reasonable plan for the discipline in Ontario, but in any case this set of plans is the first approximation to the provincial plan, which the planning assessment may have to refine if there are duplicated features, lacunae in offerings, too large a total enrolment or other reasons to recommend altering some of the university plans. The universities are also involved in that the bodies that act on ACAP reports, i.e. both COU and OCGS, are composed of universities.

The formal documents stating the responsibilities of ACAP and the discipline groups are Appendix F. Briefly summarized, it is ACAP's function to advise on steps to be taken to implement effective provincial planning at the graduate level, to promote the arranging of the graduate programmes of the province in order to enhance and sustain quality and to avoid undesirable duplication, and, when necessary, to carry out formal planning

reviews for disciplines. A discipline group has the responsibility of keeping under review the plans for graduate work in the discipline and making regular progress reports to ACAP in connection with graduate work in that subject. To make all this possible, it has been agreed that ACAP may communicate directly with universities and discipline groups, to request necessary information, to discuss reports, to convene meetings, and to make and receive proposals for the future.

The above information has been given in some detail because it constitutes the mechanism currently approved by COU for cooperative graduate work. It is fair to say that in 1971 there was no mutually agreed plan for graduate study in any discipline. Our task is not only to generate the first such plan for each subject but also to ensure that it is kept under continual review.

There are four fundamental components in the plan. The first is analysis of the fields of study, the formats of study which should be available to prospective students in the province. The second is an estimate of overall provincial enrolment at master's and doctoral levels based principally on the likely numbers of highly qualified applicants. In regard to considerations of manpower needs for the province of Ontario, ACAP is conscious of the unreliability of forecasts and, except in special cases, subscribes to the approach proposed in the Macdonald Report (1969):

> "The country as a whole and the provinces must be concerned about manpower requirements. This concern can be expressed in the first instance through careful survey and forecasting of manpower needs on a continuing basis. Such forecasts should be given wide circulation. It is reasonable to expect that universities will respond by creating additional opportunities for study in the areas of shortage. In addition, the universities through their counselling services have a duty to advise students about the opportunities in various fields from the standpoint not only of intellectural challenge but also of vocational prospects and social utility. The reaction of prospective students to such forecasts is likely to provide an effective control. We believe the market-place, if its trends are made explicit, offers an adequate governor to prevent serious surfeit and to encourage movement of students toward fields of opportunity."

The third component of the plan is an indication of the role to be played by each department in terms of the programme it will offer and its academic emphasis. Cooperative arrangements between departments are stressed. The fourth component consists of an examination of the enrolment plans of the universities and consideration as to whether the universities' plans and the predicted enrolment for this discipline are consistent. If not, some appropriate action should be recommended to COU. It will be seen that although there may also be other aspects, these are four necessary components in such a plan.

In the case of solid earth sciences, there is no major enrolment mismatch.

One must hasten to add that the future is uncertain and that to forecast intellectual trends, student interests, and employment markets five years hence is to undertake to examine many variables. Of course, this is not a new exercise since all universities have had to make decisions about building, staff hiring, library expansion, equipment investment and so forth and have done so on a basis of similar forecasts. Perhaps sometimes the forecasts have been more intuitive than consciously recognized, but they have certainly been there. All that is new is to make such plans systematically for the province.

It will be realized that, at a minimum, the ongoing planning procedures we have indicated requires annual reporting of enrolments and annual examination of admissions standards. When there are indications from these or other sources that some aspects of the plan for the discipline are not being realized, it will be necessary for ACAP to initiate a review. Such a review would usually not involve outside consultants. Whether the impetus came from a discipline group, a university or ACAP itself, comments would be sought from all concerned and the review would culminate in a report to COU recommending an amendment to the plan.

If a university notifies ACAP of its intention to depart from its accepted role (for example to enrol numbers substantially at variance with its understood plan), ACAP will review the situation in the light of any other such notifications it may have received and any other pertinent factors. The extent of any further study would depend on the situation, but if ACAP felt that the university's new plan could be a cause for concern, its first step would be to seek full discussion with the university. Normally there would already have been discussion in the discipline group and between universities and the university would have reached its intention after a careful examination of the general situation of graduate study in the discipline. Thus the ACAP decision would be straightforward and a change in plan would be recommended to COU through OCGS. If, however, ACAP still felt that there was a probability that the university's action might be found, on further study, to be potentially harmful to the system, it would probably next seek comment from other universities concerned and from the discipline group. In any case, ACAP would eventually make some recommendation to COU (through OCGS) concerning the variation.

It is difficult without a concrete case to speculate on likely recommendations, but perhaps two hypothetical situations will illustrate the extremes. If a university indicated that, without any marked change in the academic emphasis of its department, it proposed to arrange to enrol somewhere around 70 graduate students instead of about 50, and if there were no changes at other universities and no potential developments which could be substantially affected, ACAP would presumably simply notify COU of the university's intention and recommend that it be recognized as an alteration in plan for the discipline. At the other extreme if a university proposed to begin a new programme designed to enrol fairly soon some 30 PhD students in a field of the discipline already well covered in other universities, it would clearly be necessary to obtain reaction from the discipline group and from other universities and perhaps even some expert advice, in order for ACAP to generate an advisory position concerning the impact of the proposal on the system and suggestions to the university concerned and to COU. As has been noted, if there had been advance inter-university

discussions and agreement, this would be a positive factor in ACAP's assessment, but there is of course the possibility that the recommendation would call for modification of the university's intention; we take that to be the obvious consequence of system planning. Of course, the university could decide to act in a manner contrary to a COU recommendation, accepting whatever consequences would result; we take that to be the basic right of university autonomy. It is understood that a university will not act in this way without the notification and review described in the preceeding paragraph.

GENERAL RECOMMENDATIONS

This section contains discussions of all the recommendations that refer to graduate studies in the Ontario solid earth science system as a whole. The next section will deal with the universities individually.

Enrolment

One of the important aspects of these planning assessments is a discussion of the likely picture for enrolment and for job opportunities.

In general, ACAP anticipates growth in graduate enrolment in the solid earth sciences but not on the scale recommended for planning purposes by our consultants. There are many indicators. Over the last seven years the total graduate enrolment has been rising slowly to its present level of 431 graduate students, but the increased rate of growth that would have realized the projections shown on page A52 of the consultants' report has not materialized. (See Table 1.)

In the past, non-Canadians have made up 40% of the master's students and about 60% of the PhDs. Due to recent changes in the immigration regulations and the restrictions on financial support for foreign students, a downward trend in the number of non-Canadians should soon be evident.

Let us take an extremely optimistic view of the employment market in order to learn what size doctoral enrolment it can support. If the industrial employment for new PhDs for the next five years is twice what it was in the past, and if government jobs and fellowships increase 50% and if university employment also increases from 7 per year to 10 per year - all of these are very optimistic and assume great need for earth scientists - there will be jobs for 43 new PhDs per year. (Based on Table 2.6, page A17.) If the average time from master's degree is 3.5 years, that would imply jobs for an enrolment of 151 doctoral students, and if it takes 4 years, the corresponding enrolment would be 172. The enrolment for the last six years (1968-69 to 1973-74) has been between 155 and 175. The output has averaged just about 30 per year.

We do not know what effect if any the current energy crisis will have on graduate work in solid earth science. We feel that it will, at least, keep the graduate enrolment at the present level and at most should make our optimistic employment picture quite realistic.

It is possible more Canadian students may elect to undertake graduate studies and may replace the loss of non-Canadian students. There would then perhaps be more Canadians to fill Canadian jobs and somewhat reduce the number of geologists that it has seemed necessary to 'import'.

The consultants' report, which was based on 1971-72 data and written in 1972-73, gives enrolment forecasts starting with 1973-74. These can easily

Table 1

Graduate Enrolments

1967-68 to 1973-74

	1967-68	'68-69	'69-70	'70-71	'71-72	'72-73	'73-74
Geology Departments							
Master's	79	107	123	119	156	169	204
Doctoral	99	119	124	129	124	112	121
Geography Departments							
Master's	17	23	41	48	40	N.A.	48
Doctoral	8	15	18	19	26	N.A.	20
Geophysics Departments							
Master's	14	12	13	18	17	27	22
Doctoral	18	21	29	28	22	17	16
Total							
Master's	109	142	177	185	213	N.A.	274
Doctoral	125	155	171	176	172	N.A.	157
Total	234	297	348	361	385	N.A.	431

NOTE: Guelph's Soil Science is included in Geology Department numbers.

N.A.: Not available. Physical geography was not separated from geography enrolments when the data were requested in 1972-73.

be compared to actual enrolment data.

	Recommended by Report		
	Probable	Minimal	Actual
Total	462	400	431
Master's	277	240	274
Doctoral	185	160	157

As can be seen present enrolment at the doctoral level is about the minimum expressed by the consultants while the master's enrolment approximates their maximum.

Lastly, an indication suggesting growth is that the undergraduate enrolment in geology honours and majors courses has been growing more rapidly than the general student body. If we appear to be optimistic in our assumptions about enrolment, it is because of this undergraduate increase and the possible effects of the energy crisis.

Recommendation C1

It is recommended that the universities plan on the basis of modest growth, using the consultants' minima as probable figures.

	1977-78	1982-83
Total	510	620
Master's	306	370
Doctoral	204	250

With new programmes at Brock, Queen's, Waterloo and Windsor, one can expect limited growth elsewhere. This does not mean that there should be no new areas developed in current programmes but it does suggest that they will likely develop at the expense of enrolment in established areas.

It is our task to consider the connection between the likely provincial enrolment figures and the stated plans of the universities. In so far as these are clearly given in the various university statements to us, there appears to be no problem. Of the four universities with largest enrolment, McMaster states its view that the consultants' probable figures may be reached, Western Ontario indicates its readiness to take more students, Queen's intention is to grow less than the consultants' minimum figures and Toronto anticipates greater growth than seen by the consultants. Some of the smaller universities are already very near or even in excess of the enrolments suggested by the consultants in Table 5.5. These figures, then, should be used only as rough guides. Probably the six universities for which this table shows enrolments over 40 should not expect to reach quite the numbers shown.

Admissions

Recommendation C2

It is recommended that admissions policies continue to be based on academic standards with an adequate level of financial support for each student. Of course, the number of students admitted to a department is also bounded by the capacity of the department to accommodate students, a capacity which will have been planned in accordance with Recommendation C1.

The similar Recommendation 2.1 of the consultants, which is supported by the Geology Discipline Group and several universities, does not contain the reference to available capacity and, if taken literally, implies that the number of graduate students should be controlled by the amount of the funds made available for their personal stipends. But many other factors - number of professors, research space, research equipment and so forth - also limit the enrolment. Also there should be enough flexibility to allow for the rare student who does not require support. It is most important to continue to ensure also that a minimum academic standard applies to all admissions. The Discipline Groups could annually monitor the admissions experience of the Ontario system.

Recommendation C3

It is recommended to the Government of Ontario, the National Research Council and the universities of Ontario that all general scholarship schemes provide for a percentage of the awards to be open to able, well-qualified graduate students from abroad in competition with Canadian applicants.

This recommendation flows from Recommendation 2.2 of the consultants. The number of non-Canadians could be maintained at the highest level of academic standards by letting them compete with Canadians for scholarships and bursaries. This is preferable to widespread support on professors' grants, since this latter mechanism does not necessarily include any comparative academic evaluation of the students.

Specialties

Recommendation C4

It is recommended that continued and increased emphasis be placed on applied specialties.

In the report and comments there appears to be general agreement that this is an important point. ACAP has accepted the comments of the Discipline Groups and of some universities and considers the three applied specialties specifically mentioned in the consultants' Recommendation 3.1 solely as examples. We note too that universities other than those named are also

engaged in the specialties mentioned.

Recommendation C5

> It is recommended that except as noted below no new programme in geophysics be started in the next five years.

The two programmes in geophysics involve at present only 45 students, 17 of these at the doctoral level. Any moderate increase in enrolment could be handled quite easily by the existing two departments. Should there be a noticeable increase in the interest in this field, then ACAP would welcome plans from any interested university to mount the third programme.

It is not intended by this recommendation to disagree with the consultants on the importance of a greater emphasis on geophysics in the training of geology and geography students. On the contrary, we note that this view seems to be generally accepted in the comments sent to us. This recommendation refers to the establishment of the third programme specifically to train geophysicists.

We have been informed that CUDG(O) has set up a committee to study the desirability and possibility of such a new geophysics programme. When this study is completed, it will be of assistance in evaluating any university proposal which comes forward under this recommendation.

Recommendation C6

> It is recommended that departments and the Discipline Groups consider the consultants' view that greater emphasis should be placed on limnology, marine geology, applied environmental geology and geophysical techniques.

Throughout their report the consultants draw attention to the lack of geophysics in the geology departments. They feel basic geophysics will aid geologists working in a variety of fields. Concern is also expressed about the amount of work in the Ontario system on physical limnology and marine geology. ACAP has noted the universities' various comments about work in this and the environmental areas and perhaps it is a task for the Discipline Groups to consider the adequacy of the coverage of these particular specialties in the province, and to make specific suggestions if some action seems desirable.

Recommendation C7

> It is recommended that Carleton University and the University of Ottawa consider some formalization of the existing cooperative aspects of the work of their geology departments, and inform COU of the results.

The consultants suggest that Carleton and Ottawa should operate a joint earth sciences programme. In general, ACAP encourages the form of cooperation between universities which is most effective, in the particular circumstances, in enhancing the academic opportunities for the students and use of library and

equipment. The best mechanism may sometimes be a joint programme, sometimes other arrangements are equally or more satisfactory. It is however advisable that such arrangements be carefully formalized, for otherwise there can be a tendency for the reality of the cooperation to diminish.

In the case of the geology departments in Ottawa, there appears to be very considerable cooperation, including joint decisions about course offerings, graduate student admissions, faculty hiring and fields of interest. This seems to us to be remarkable progress and we feel that all that is necessary at this time is to strengthen this quite satisfactory arrangement. Of course, closer arrangements may develop later.

ACAP also accepts the validity of the comments made by the two universities about the internal and external involvements of their geography departments in earth sciences and does not suggest accelerating any changes.

Programme Development

Recommendation C8

> It is recommended that no new doctoral programmes, other than those recommended in this report, be considered for commencement during the period to 1977-78.

Because of the enrolment forecasts which only envisage moderate growth, at the doctoral level, no further doctoral programmes should be proposed until the end of the first planning period. If the enrolment pattern should change markedly, then ACAP would examine carefully any proposal brought forward for a new doctoral programme.

ACAP concurs with the consultants' Recommendation 4.4 about the desirability of some supporting research conducted without involvement with a graduate programme.

Recommendation C9

> It is recommended that urgent attention be given to the question of research funding for professors whose departments do not offer graduate programmes in their fields, and also that post-doctoral fellows be given a B.I.U. weight.

Master's Programmes

There are recommendations in the consultants' report for reappraisal of several master's programmes. We do not concur in all of these and will discuss each in connection with the individual universities. Here we should note the embargo situation, since the document from the Geology Discipline Group may be confusing on this point. Geology and geography are both 'central disciplines' and therefore no embargo applies to master's degrees at the

'emerged' universities. This is not to say that such universities should not carefully consider and normally act on recommendations about fields of study, enrolments, and so on, if these come from a planning assessment. Brock, Lakehead, Laurentian and Trent, on the other hand, are constrained in their graduate programmes by the five year plan which each puts forward and for which funding is assured when the plan has ministerial approval. A request can be made to add to the five year plan, or otherwise modify it, and this would require reconsideration of the university's total graduate studies offerings.

York University and Trent University have both indicated no plans in the near future for any graduate work in the solid earth sciences.

Professorial Accreditation

The consultants in Recommendation 4.3 suggest an arrangement for 'accreditation' as doctoral supervisors of individual faculty members at universities which do not have doctoral programmes. The Discipline Groups have expressed reservations about this proposal and we too have reservations. ACAP does believe that the cross-appointment of specific individuals to specific departments is to be encouraged and it may be that there are some more extensive possibilities. During 1974-75 ACAP hopes to make a study of the problems inherent in various approaches to the operation of joint programmes and other forms of collaboration.

Leadership and Cooperation

ACAP draws the attention of the Discipline Groups and departments to the consultants' Recommendations 5.1 to 5.5. These are comments directed specifically to the solid earth science community and ACAP has no comment.

Role of Discipline Groups

As the Discipline Groups continue in their normal role as outlined in Appendix F, ACAP proposes to ask them in particular to advise on the distribution of specialties and neglected fields, annually to review admissions experience and to recommend to ACAP any modifications that might be made to the plan.

In acknowledging the ongoing work of the Council of University Departments of Geology (Ontario) and the Association of Ontario Geomorphologists, ACAP feels it is worth mentioning that these organizations work in parallel with the Geology and Geography Discipline Groups and not in lieu of them.

UNIVERSITY RECOMMENDATIONS

This section gives a recommendation for each university concerning its present state and future plans. Following each recommendation is a comment on the programme strengths found in the various departments; these are based on the consultants' report, with attention paid to the university comments.

Recommendation C10

> It is recommended that Brock University continue its master's programme in quaternary geology in accordance with its stated plans.

Brock has a strong group of workers in environmental studies, specializing in quaternary geology. Geomorphology is integrated into this quaternary programme, with excellent teaching facilities and a radiocarbon laboratory.

Recommendation C11

> It is recommended that Carleton University continue its master's and doctoral programmes in geology in collaboration with the University of Ottawa, and its master's programme in physical geography according to its plans.

Carleton has strength in its geology department in engineering geology, structural geology, economic geology and petrology with quite good facilities for geochemistry. ACAP notes Carleton's emphasis on precambrian geology and as the consultants agree this is entirely appropriate, ACAP finds the University's intention of strengthening this field unexceptionable. We note also the University's comments concerning the third geophysics programme and we refer to the earlier statement on this subject, Recommendation C5.

ACAP encourages the continuing efforts between Carleton and Ottawa towards a joint programme in geology. Further comments have been made in Recommendation C7.

ACAP agrees with the universities that no attempt should be made to join the geography programmes at these universities. The physical geography activities at Carleton are expanding and the programme seems to be well-equipped. The consultants consider the emphasis on permafrost research to be well chosen.

Recommendation C12

> It is recommended that the University of Guelph continue its master's and doctoral programmes in soil science and master's work in geomorphology in the Geography Department. The desirability of extending the scope of the doctoral programme should be a matter for recommendation by ACAP when the University has a detailed proposal.

The consultants commend the University of Guelph for its decision to develop a department concentrating on soil sciences rather than a traditional geology department. Guelph has done an outstanding job of integrating various disciplines with its soil science study. The University is well equipped to continue to develop further activity in applications of remote sensing to land use problems and detailed studies of soil systems as related to waste disposal.

In commenting on the consultants' report, the University asked whether or not the consultants considered a future doctoral programme in geomorphology, as there is no comment on it in their report. The consultants could not have dealt with this in detail, since the University's statement of future plans is, understandably, imprecise on this subject, referring to a "suggestion for a PhD programme at some future time...". The encouragement given in Recommendation 3.1 provides grounds for further study if the University develops in this direction. It is noted that the doctoral programme, appraised in May, 1970, is in any case due for re-examination in 1975.

Recommendation C13

> It is recommended that Laurentian University continue its master's programme in geology, but also submit it for appraisal. Since there are arguments in favour of a geology master's programme in Sudbury, consideration should be given, if the appraisal should be negative, to the alternative of strengthening rather than closing the programme. If a favourable appraisal has not been obtained by January 1, 1976, the enrolment of new students should be suspended.

Although this programme received a favourable appraisal in 1969, the consultants feel it needs to be re-examined. They also urge the strengthening of the subdisciplines that the Sudbury area make the most obvious choice in a geology programme. There is a need for applied economic and mine geologists. Laurentian is also undergoing a rearrangement of its graduate programmes in connection with a new five year plan. The date for the completion of the appraisal was chosen with this internal readjustment in mind. The internal planning may have an effect on the nature of the geology programme offering.

Recommendation C14

> It is recommended that McMaster University continue its master's and doctoral programmes in geology and its master's and doctoral programmes in physical geography according to its plans.

The consultants were pleased to note the interdisciplinary character of the whole university. Sedimentology, mineralogy and paleontology are strong in the geology department and there appears to be only a small amount of geophysics. There is also exceptional strength in elemental geochemistry. The consultants consider McMaster the outstanding centre of geomorphology in the province; the group is well equipped and specializes in karst morphology and pedology.

Recommendation C15

> It is recommended that the University of Ottawa continue its master's and doctoral programmes both in geology and in geomorphology in the geography department, on the assumption that cooperation with Carleton will continue in geology and between geology and geography internally.

ACAP notes the consultants' comments of overextension in the doctoral programmes at Ottawa and the University's subsequent reply. It is felt that the close cooperation with Carleton is important, since the Ottawa department (faculty and students) is rather small for independent doctoral work; the Ottawa contribution is also important to Carleton. Recommendation C7 discusses the Carleton-Ottawa situation more fully.

Ottawa has considerable potential for research in structural geology and petrology, as well as notable activity in sedimentology and geochemistry. The work in applied geomorphology is also strong. The lack of geophysics noted by the consultants is a deliberate policy on the part of Ottawa because Carleton provides this field. This is just one of many examples of real cooperation between the two universities in the earth sciences field.

The University's comment on the cooperation between its Departments of Geography and Geology is noted and is considered valuable.

It seems to ACAP very reasonable to consider the consultants' 1977-78 enrolment as a guideline for Ottawa's total earth science activity, not just geology.

Recommendation C16

> It is recommended that Queen's University's master's and doctoral work in geology and master's work in physical geography continue as planned. It is recommended that the Geography Department commence to offer its doctoral programme in geomorphology and pedology.

Queen's is very strong in economic geology, petrology and mineral geochemistry with increasing capability in marine geology. The consultants were pleased at the cooperation between geologists and physical geographers. The latter have a noteworthy programme and are particularly well equipped for pedological work. Their new doctoral programme was appraised favourably in September 1971. There is apparently a weakness in geophysics which should be strengthened somewhat to support the geological research. ACAP notes Queen's statements that although it might take earlier steps in regard to geophysics in geology, it would not contemplate developing a major geophysics programme until 1980; this is consistent with our Recommendation C5.

Recommendation C17

> It is recommended that the University of Toronto continue its programmes for master's and doctoral work in geology, physical geography and geophysics in accordance with its plans.

The University of Toronto has a well-rounded solid earth science programme with notable strength in the traditional fields of geology and in petrology. The paleontology effort here is greater than that of any other university. The equipment is generally outstanding. There is strength in engineering geology and the heaviest concentration in the system of geophysics and geochemistry. The geomorphologists are strong in field operations in fluvial morphology.

The consultants recommend the development of earth sciences at Erindale College, and Toronto notes that it has already taken some steps in this direction. This appears to ACAP to be essentially a matter internal to the University of Toronto and one on which ACAP need not comment, beyond drawing attention to our views on enrolment prospects.

Recommendation C18

> It is recommended that the University of Waterloo continue its master's programme in earth sciences and also its new doctoral programme in environmental geology, specializing at both levels in groundwater geology and engineering geology as appraised.

Waterloo is very strong in environmental geology, in particular, groundwater geology. ACAP recommends that the doctoral programme should be funded. (It was favourably appraised in December, 1971 and has one student enrolled at present.) The level of enrolment should be such as to maintain a viable level and subsequently ACAP endorses the enrolment plans of the University, viz 6 to 10 doctoral students.

Recommendation C19

> It is recommended that the University of Western Ontario continue its master's and doctoral programmes in the Departments of Geophysics and Geology (including the geomorphology programme within the Geology Department) and also the graduate work in pedology in the Geography Department.

ACAP feels the Geophysics Department at Western is small at present and could handle a substantial increase in enrolment. If the geophysics enrolment should rise beyond the capacity of Western and Toronto combined, then a third programme may have to be considered. For further clarification of this, see Recommendation C5.

Western has an outstanding research group in geomorphology located in its Geology Department. The department also does good research in paleontology

and is strong in economic geology. We note that the faculty strength in geochemistry has increased substantially since the initial collection of the data for this study. Pedology, the only active solid earth sub-discipline in physical geography, has the approval of the consultants. The geophysics programmes achieve an excellent balance between a pure and applied emphasis.

Recommendation C20

> It is recommended that the University of Windsor continue its master's programme in geology and that it submit its master's programme in physical geography for appraisal with the understanding that it cease to accept new students as of January 1, 1975, if a favourable appraisal has not been obtained by that date.

The master's programme in geology received a favourable appraisal in May, 1973 and consequently may go forward whenever Windsor wishes to start. ACAP would, however, like to draw Windsor's attention to the consultants' comments about the breadth of fields covered in this master's programme. The consultants feel that "petroleum geology and industrial minerals" is too broad a programme for the resources of the department. ACAP urges Windsor to consider specialization and notes with approval the University's comment about restricting the specialties.

In the light of the consultants' comments about the physical geography programme, there is no alternative to recommending that it be appraised. Perhaps the University would consider it advantageous to appraise the Geography Department as a unit.

Recommendation C21

> It is recommended that COU adopt the recommendations of this report, and, in the expectation that its members will act in accordance with them, COU inform CUA that it has adopted these recommendations and request that the embargo on solid earth sciences (including geomorphology and pedology) be now removed, in accordance with the original announcement of the Minister that new graduate programmes would be embargoed until, for each discipline, a planning study had been conducted.

APPENDIX A

REPORT

of the

SOLID EARTH SCIENCES CONSULTANTS

to the

ADVISORY COMMITTEE ON ACADEMIC PLANNING

ONTARIO COUNCIL OF GRADUATE STUDIES

COUNCIL OF ONTARIO UNIVERSITIES

F.A. Campbell

M.J. Dunbar

G.H. Dury

R.D. Russell

SEPTEMBER, 1973

A false balance is an abomination to the Lord; but a just weight is his delight. -- PROVERBS, 11,i.

TABLE OF CONTENTS

Page

TERMS OF REFERENCE ..... A-iii
SUMMARY OF RECOMMENDATIONS ..... A-v
ABBREVIATIONS USED ..... A-ix
PREAMBLE A-1
SECTION 1: OBJECTIVES AND PROCEDURES A-1
1a. Significance of the Ontario Solid Earth Sciences System A-1
1b. Objectives of the Consultants A-2
1c. Procedures A-3
1d. Difficulties and Reservations A-4
SECTION 2: THE PRESENT ONTARIO SES SYSTEM A-5
2a. Institutions and Faculty A-5
2b. Graduate Students A-9
2c. Undergraduate Base and Department Status A-18
2d. Facilities A-23
SECTION 3: ROLE OF THE ONTARIO SES SYSTEM A-24
3a. Role Within the University A-24
3b. Search for Material Resources A-26
3c. Social Responsibilities A-26
3d. Academic Pursuits A-27
3e. Resources A-27
SECTION 4: STRENGTHS AND WEAKNESSES A-28
4a. General Comments A-28
4b. Assessment A-28
General Statement A-28
McMaster, Queen's, Toronto, and Western A-33
McMaster University A-34
Queen's University A-34
The University of Toronto A-35
University of Western Ontario A-36
Carleton and Ottawa A-36
Carleton University A-37
University of Ottawa A-37
Brock, Lakehead, Laurentian, Waterloo and Windsor A-37
Brock University A-38
Lakehead University A-39
Laurentian University A-39
University of Waterloo A-40
University of Windsor A-40
The University of Guelph A-41
SECTION 5: RECOMMENDATIONS A-42
5a. Enrolment Projections A-42
RECOMMENDATIONS 1: PROJECTED GRADUATE ENROLMENTS IN SES A-50
5b. Graduate Admissions and Conditions of Graduate Candidacy A-52
RECOMMENDATIONS 2: ADMISSION POLICIES A-53
5c. Development of Specialisms, and Expansion at Particular Centers A-54
RECOMMENDATIONS 3: FURTHERANCE AND EXTENSION OF SPECIALISMS A-55

Page

5d. Programme Restriction and Personal Accreditation..... A-56
RECOMMENDATIONS 4: PROGRAMME DEVELOPMENT AND PERSONAL ACCREDITATION..... A-57
5e. Leadership and Cooperation..... A-58
RECOMMENDATIONS 5: LEADERSHIP AND COOPERATION..... A-59
5f. Self-appraisal A-60
RECOMMENDATIONS 6: SELF-APPRAISAL A-61

LIST OF ILLUSTRATIONS

Fig.		Page
2.1	Faculty on research and graduate instruction: distribution	A-8
2.2	Graduate enrolment and faculty numbers	A-11
2.3	Flow of Masters' Candidates through the system	A-13
2.4	Flow of Doctors' Candidates through the system	A-14
2.5	Graduate student citizenship	A-16
2.6	First year undergraduates and FTE faculty	A-19
2.7	Second to fourth year undergraduates and FTE faculty	A-20
2.8	Undergraduate/faculty ratios	A-21
5.1	Some projected growth trends	A-43

LIST OF TABLES

Table		Page
2.1	Research and graduate instruction	A-6
2.2	Research and graduate instruction, percentages of system total	A-7
2.3	Graduate enrolment and Ph.D. employment	A-12
2.4	Graduate student citizenship	A-15
2.5	Employment of Canadian Ph.D.'s	A-17
2.6	Employment of Ontario SES Ph.D.'s	A-19
2.7	Libraries	A-25
4.1	Distribution of Masters' students	A-30
4.2	Distribution of Ph.D. students	A-31
5.1	Projections of student population; model for SES graduate population	A-44
5.2	Projections of SES graduate enrolment and output	A-46
5.3	Geoscience enrolment, Canada	A-48
5.4	Planning information for Britain	A-48
5.5	Proposed distribution of graduate students	A-49
5.6	Demand Model for Ontario SES system	A-51

TERMS OF REFERENCE

1. Consider the materials prepared by the discipline group and the universities and obtain other data they may require to carry out the tasks detailed below. They may obtain data and views from any relevant source, such as, for example, employers of holders of graduate degrees, professional and learned societies, federal agencies. The campus of each interested university shall be visited by at least two consultants. Consultants shall arrange their schedule of visits to the universities in consultation with ACAP to ensure uniformity. Reports of appraisal consultants are privileged documents and are not to be made available to ACAP consultants. Consultants shall liaise with the discipline group near the beginning of the work, during the work as they consider necessary, and immediately before preparing their final report.

2. Report on the adequacy of the present state of graduate work in solid earth sciences in the province in general and in each university where applicable, discussing the following:

   a. coverage of core elements and specialties, and extent of activity in each

   b. faculty quality and quantity

   c. nature of programmes offered

   d. enrolment size and distribution amongst universities

   e. quality of student body; admission requirements

   f. relationship to related disciplines, considering in particular the involvement of geology and geography students in training for work in oceanography, limnology, hydrogeology and glaciology

   g. physical facilities

   h. other matters considered by the consultants to be significant.

3. Make recommendations for the development of graduate work in solid earth sciences in Ontario between 1973 and 1983, but in more detail for 1973 through 1978, and, without limiting the generality of the foregoing, dealing with the following points:

   a. Desirable programmes to be offered in the province, considering both possible limitations or reductions of existing programmes and creation of new programmes and new kinds of programmes including the appropriateness of part-time programmes. In particular, consider possible new fields in the solid earth sciences and training of students for work in application-oriented and interdisciplinary work

in which solid earth sciences should be involved.

b. Desirable provincial enrolments, year by year, in the various levels of graduate study and specialties, where appropriate. One should consider the need for highly trained manpower and also the general cultural and societal factors which may lead students to pursue graduate work in solid earth sciences. In considering manpower needs, one should take account of the "market" available to graduates (at least all of Canada) and of other sources of supply for that market. Results of forecasts of high level manpower employment should be treated with due caution and only in a clearly balanced relationship with cultural and societal needs.

c. Distribution amongst the universities of responsibility for programmes and for specialties where appropriate, including consideration of the need for any increase or decrease in the number of departments offering doctoral work and including consideration of areas of collaboration and sharing of facilities at regional level and across the province.

d. Distribution of enrolment amongst the universities, showing desirable ranges of enrolment.

e. Desirable extent of involvement with related disciplines, identifying any suggested areas for greater collaboration.

In all cases, it is important that the rationale for the recommendations be clear; this is especially important for items c. and d. Consultants are asked to comment on advantages and disadvantages of various techniques for arranging that their recommendations become effective.

It is permissible for consultants to recommend appraisals of individual programmes. This would arise if consultants were to suspect that a programme would be found to be wholly or in part below minimum acceptable standards; an appraisal by the Appraisals Committee is the means of settling the question. It is recognized that this action would be infrequent. Perhaps more likely, in planning assessments in some disciplines, consultants may find an excess of programmes in the same area of study, all of which could pass an appraisal; they would then have to make their own judgements of relative quality (a task outside the terms of reference of the Appraisals Committee), and guided by this judgement and other factors, the ACAP consultants would have to recommend where enrolment should be curtailed or eliminated.

SUMMARY OF RECOMMENDATIONS

1. *PROJECTED GRADUATE ENROLMENTS IN SES*

1.1 Enrolment projections should be based on the demographic projections made by DTE and cited in the Wright Report.

1.2 Projections of graduate enrolments in SES should be based on an approximate mean between a nil increase in university participation by the relevant age group, and the rate of increase forecast in the Wright Report. That is, the projections should be based on an increase of about 7% per annum during the first five years, and 4% per annum during the second five years.

1.3 Future graduate enrolments in SES should be estimated to continue at about 60% Master's, 40% Doctor's.

1.4 On the basis of 1.1, 1.2, and 1.3, the following projections should be adopted for planning purposes. The larger figures we consider to be the most probable; those in brackets represent the minimal enrolments.

	1973/74	1977/78	1982/83
Total SES Graduate Enrolment	462 (400)	593 (510)	725 (620)
of whom Master's	277 (240)	358 (306)	435 (370)
of whom Doctor's	185 (160)	235 (204)	290 (250)

1.5 Although we regard our projections as conservative, involving (so far as we can determine) no risk of a Ph.D. surplus in SES, the current situation should be kept under constant review.

1.6 If our predictions prove to be seriously in error, to the extent that the SES graduate population in Ontario increases very slowly or not at all, then the whole situation should be reevaluated. Although we view with distaste any selective penalization of SES units, a serious contraction of graduate enrolments could make it appropriate to consider a reduction in the number of such units.

2. *ADMISSIONS POLICIES*

2.1 Admissions should be based solely on academic criteria. An admitted student should be assured of financial support at a minimum level of adequacy. No attempt should be made to use reduction of support or increase of fees as a means of curtailing enrolment.

2.2 Extreme caution should be exercised in raising financial barriers to the international exchange of graduate students.

3. *FURTHERANCE AND EXTENSION OF SPECIALISMS*

3.1 Continued and increased emphasis should be placed on applied specialisms. Quaternary studies at Brock, pedology-geomorphology at Guelph, and environmental groundwater engineering at Waterloo should be developed.

3.2 The establishment of a third major geophysics group, additional to the groups at Toronto and Western Ontario, should be considered. Such a third group could appropriately be located in a major department already well qualified in economic and structural geology, such as the Geology Department at Queen's.

3.3 Particular consideration should be given to the development of graduate studies in marine geology, with especial reference to the Hudson's Bay area. This recommendation takes account of the length of Ontario's sea coast, and the growing scientific and economic importance of continental shelves.

3.4 The University of Toronto should consider accelerating the development of SES facilities at the Erindale campus.

3.5 Every effort should be made to merge the SES graduate programmes at Carleton and Ottawa.

4. *PROGRAMME DEVELOPMENT AND PERSONAL ACCREDITATION*

4.1 Ph.D. programmes in SES should not be considered during the first five-year period for Brock, Lakehead, Laurentian, and Windsor. The status and potential of these centers should be reviewed at the end of that period, in order to determine if the institution of a Ph.D. programme in one or more of them would be in the provincial interest.

4.2 It should be accepted that the projected graduate enrolments for the first five-year period can be accommodated in the SES system without Master's programmes at Lakehead, Laurentian, and Windsor. Existing or proposed SES graduate programmes at these centers should be reappraised. Reappraisals should have regard to choice of areas of specialization, in relation both to the SES system and to the location of a given unit.

4.3 Notwithstanding the restrictions on centers recommended in 4.1 and 4.2, a mechanism should be developed to accredit individuals, wherever located in the system, to direct graduate work in particular subdisciplines or subdisciplinary groups, either at the Master's level or at the Doctor's level, as appropriate. Financial inputs resulting from personally accredited supervision should benefit the institution to which the accredited supervisor is attached.

Methods of individual accreditation could be worked out for instance by CUDG(O), and could take account of the formalized practices, e.g., of the Universities of Toronto and London (U.K.).

4.4 Because we see inherent dangers in relating all research to graduate degree programs, we recommend that funding be made available by Ontario for research independent of these programmes.

5. *LEADERSHIP AND COOPERATION*

5.1 SES units should accept its important role in environmental studies, taking the fullest possible advantage of the interdisciplinary nature of the solid earth sciences, and of the broad competence of the geoscience professions in the study of the earth.

5.2 Means of improving cooperative endeavor should be earnestly pursued.

5.3 Some appropriate agency should be charged with attempting to remove, or at least to lower, structural and procedural obstacles to close and formalized cooperation between university units on the one hand, and governmental and industrial units on the other.

5.4 Solid earth scientists, as a group, should take a more direct interest than hitherto, in such applied fields as geotechnique, engineering geology, and resource-related studies, in order that SES graduate students may cultivate a strengthened interest in applied aspects, in addition to pure aspects, of their disciplines.

5.5 Attempts should be made to remedy the diseconomy of distribution and use of major equipment and associated expert personnel, which now exists in certain respects, by one or more of the following means:

(a) Operation of major fixed equipment on a three-shift, or at least a two-shift, basis;

(b) Transfer of some items from departmental to group or university control;

(c) Guarantee of access (e.g., for night shifts) to needful workers from nearby centers or to periodic visitors;

(d) Continuing provision of sufficient academic and support staff for facilities that serve the system.

(e) Inventory, with a view to redistribution, of idle or otherwise surplus equipment.

6. *SELF-APPRAISAL*

6.1 CUDG(O) should be encouraged to collate and distribute data on the geological-geophysical units in the SES system. If possible, perhaps by cooperative endeavor, its tabular summaries at least should include also data on pedology and geomorphology. In addition, CUDG(O) should be encouraged to produce sequels or supplements to its Report.

6.2 Members and units of the SES system should consciously assess the objectives that might be thought desirable for the system. Among possible objectives considered could be:

(a) To supply world leadership in some aspects, and by some centers;

(b) To supply leadership for Canada;

(c) To supply Ontario, Canada, or a wider market with trained professionals and/or intellectual pioneers;

(d) To sponsor system-wide specialty meetings or seminars for SES faculty and graduate students.

6.3 Members and units of the SES system in Ontario should think earnestly about what prospective interdisciplinary and intradisciplinary combinations there could be, in addition to those already existing or foreshadowed; and about possible major shifts in research design and direction.

ABBREVIATIONS USED

ABD	all but dissertation: condition of a Ph.D. aspirant when coursework is completed, research has been done, and only the writing-up, or part of it, remains outstanding.
CAGS	Canadian Association of Graduate Schools annual statistical reports.
CUDG(O)	Council of University Departments of Geology (Ontario).
CUDG(O) Report	Report to Committee of Presidents of Universities of Ontario, from Council of University Departments of Geology (Ontario). Ed. R.W. Yole; undated, but thought 1970/71.
DTE	Department of Treasury and Economics
FTE	Full-time equivalent.
SES	Solid earth sciences.
Wright, Wright Report	Draft Report, 1972, Commission on Post-Secondary Education in Ontario.

PREAMBLE

In February 1972, ACAP invited three of us -- Campbell, Dury, and Russell -- to act as expert consultants in Solid Earth Sciences, with the terms of reference displayed above. All three accepted. Subsequently, the fourth member of our team, Dunbar, was added as the independent scientist, non-expert in SES but familiar with the national academic and scientific scene.

Preliminary enquiries and analysis of data led in June 1972 to a conference in Toronto, where the SES consultants were additionally briefed by Dr. Preston, drew up a provisional plan of further operations, and took part in a joint session with the Geology and Geography Discipline Groups. At this session, most of the kinds of information that the consultants expected to need, additional to those already listed by ACAP, were identified. From August through November 1972, we made on-campus visits from time to time. Ideally, it would have been desirable for the whole team to spend at least one day with each SES center operating, or aspiring to operate, an SES graduate programme, and for us to have ample time for immediate consultation among ourselves. In any event, other commitments restricted whole-team visits to Carleton, McMaster, Ottawa, Queen's, Toronto, and Western. Two consultants on one occasion, and a third on another, visited Guelph. Two-man teams went to Brock, Lakehead, Laurentian, Waterloo, and Windsor, and (somewhat briefly) to the Erindale campus of Toronto.

From September through December 1972 we were analyzing the returns made by individual units and individual faculty in response to the original ACAP requests, our own requests made at the June conference with the Discipline Groups, and supplementary requests originated by us later. During January and February 1973, we held meetings and conferred by telephone while working on a draft report. The report was distributed to the SES Discipline Groups in mid-February, and discussed with those Groups in Toronto on 24 February 1973. This final Report has been modified (mainly by amplification) from the draft report, in the light of the 24 February conference, and subsequent discussions and correspondence with ACAP.

SECTION 1: OBJECTIVES AND PROCEDURES

1a. Significance of the Ontario Solid Earth Sciences System

The Ontario solid earth sciences university system is a major source of research and university training of solid earth sciences in Canada. Because of the size and complexity of the system, it is obviously worthwhile for Ontario to attempt realistic evaluations of its effectiveness, and appropriate planning for its continued development. These matters are also important outside Ontario, for the system produces a substantial proportion, perhaps one-third, of all graduates in the SES disciplines from Canadian universities. Also, the maturity and reputation of some Ontario universities involve an obligation to provide an example for the

country as a whole.

1b. Objectives of the Consultants

The terms of reference displayed above, and an address by Dr. M.A. Preston to the Council of Ontario Universities meeting of 14 September 1972, make it clear that the objectives are to provide recommendations for appropriate planning, rather than to assess individual SES centers per se. However, recommendations and individual assessments are in some ways inseparable.

We have been asked to call attention to weaknesses and strengths, to consider needs for increase or decrease in the numbers of Departments offering doctoral work, and to consider matters relating to cooperation and the sharing of facilities. Furthermore, we have been asked to estimate desirable ranges of enrolment and distribution of enrolment among the universities. We have been asked to discuss the desirable extent of involvement with related disciplines.

The subdisciplines in SES were specified as mineralogy, paleontology, stratigraphy, structural geology, geophysics, geochemistry, sedimentology, geomorphology, economic geology, environmental geology, marine geology, and pedology. This list of subdisciplines appears to have been adopted from the CUDG(O) Report. Questionnaires based on it, and dealing with facuity interests and activities, graduate programs, and related matters, were already in existence when we were recruited. Thus, although our general aim was to understand the anatomy and physiology of the Ontario SES system in its provincial, national, and international contexts, the structure of some of our enquiries and the format of part of our analysis have been constrained, to some extent, by the classification described.

Had we started from nothing, we should probably have adopted a somewhat different list. The current list makes no provision, for example, for quaternary geology or integrated quaternary studies. It leaves unclear the positions of geochronology and isotope geophysics. It makes no provision for cross-cutting biosystematic work such as that at Guelph, except for listing the pedology subdiscipline. There were considerable variations among centers in the interpretation and application of the terms listed. We found some difficulty in gathering all the relevant data on pedology-related activities. Returns on geography-based geomorphology came in very late from a few centers. And, even at this final stage, the interaction of SES with geotechnique seems to us to have been inadequately investigated -- at least, by our own team, and on the basis of information made available to us in preparation for on-campus visits. We found that geographers resent the division of their subject into two, or even three, consulting areas, but this circumstance did not produce difficulties for ourselves. Parallel objections might have been made (but were not) in respect of geophysics, because we did not consider the geophysics of the fluid

parts of the earth.

Despite the constraints of the subclassification, we hope that we have succeeded in commanding an overview of the SES system; that we have identified leading aspects of its internal variation; and that we have its various components in proper perspective.

1c. Procedures

We have had made available to us massive documentation on SES Departments and their human and material resources. Each Department supplied lists of faculty, individual research interests, current activities, publications, and funding secured. For each subdiscipline, faculty were listed by per cent full-time on research and graduate instruction, and per cent time spent on the subdiscipline concerned. Also listed by subdisciplines were numbers of faculty, master's students, and doctoral students (with a breakdown into full-time and part-time in each category), plus ABDs. Departments made returns of undergraduate numbers, by years; of graduate numbers, origins, and employment; of space, equipment, and library facilities; and of sources of funding. In addition, numbers of Departments supplied policy and/or developmental statements; and corresponding statements came in from some universities or faculties. Some system-wide summaries came from the ACAP Research Unit. The main deficiency -- indeed, the single significant difficulty at all -- is the lack of comparative data, department by department, on operating budgets: but this deficiency is due to variation in budget and funding practice from unit to unit. One set of institutional returns resulting directly from our operations results in a pile thirteen inches thick.

Without this information, we should have been unable to proceed in any useful way. We have also used the reports of various outside bodies, and the excellent analysis and self-appraisal made by CUDG(O). We shall be recommending that the work of the CUDG(O) group be continued, and possibly extended.

As stated earlier, we made a series of on-campus visits. These proved invaluable. We greatly appreciate the time and effort expended, and the inconvenience tolerated, by administrators, faculty, staff, librarians, and students, whether during class time or on weekends -- or, as at Brock, in the middle of a move to new premises. We occasionally received the comment that our visits were too short, especially for the proper evaluation of laboratories. But we consider that the visits were generally adequate for our purpose, since we possessed itemized lists of major equipment, and since the presence or absence of standard or special items, like conditions of operation and maintenance, can be rapidly estimated. Assessments, as opposed to inspections, of the various centers would, needless to say, have demanded much more time.

In general, we have taken all the information given to us by the centers at its face value. In addition, we have inevitably placed

some reliance on professional reputations.

1d. Difficulties and Reservations

It is clear to all concerned that any study of this sort must be imperfect. It is appropriate here to call attention to some matters about which we feel particularly uncertain.

It was not always clear that we had been completely informed about SES activities peripheral to the core subjects of geology, geophysics, and geomorphology. We have already stated that the interaction of SES with geotechnique seems to have been inadequately investigated, at least in the course of our own operations. Our comment could well be extended to include the whole geotechnique-engineering geology-civil engineering complex. We saw rather little of this, but were certainly gratified by what we did see. We know that much activity goes on beyond any possible frame of reference for SES, but suspect that there may be much more work at the interfaces than we became aware of. When ACAP reviews the status of graduate programmes in Engineering, care should be taken to assure that the overlaps with SES are given due consideration.

The most difficult matter is the question of recommended numbers of students. We are required to make planning recommendations based on assumptions about enrolment growth which will bracket the expected position between the first five and ten years after our report. We interpret this to mean the periods 1973/74 to 1977/78 and 1978/79 to 1982/83.

At any time this would be a difficult task. At this time the problem is exacerbated by dramatic changes in enrolment patterns, changing student attitudes, reports or claims of oversupply of Ph.D.'s at least in certain disciplines, by criticisms and adverse publicity being offered to universities everywhere. We need to distinguish, if possible, between what enrolment is desirable for the provincial and national needs and what enrolment might actually be achieved. Clearly, there could be a marked difference. We have inclined to recommend enrolments that seem to us to be desirable, in view of the size and nature of Canada and of its economy.

In using the term desirable, we have in mind not only the supply of technicians, technologists, and professionals, but also the range and incidence of educational attainment through the citizenry as a whole. Without wishing in any way to reduce the status of graduate experience, training, and qualification by the increase in graduate population, we regard it as desirable that a given individual should be able to progress as far as he can, through the educational system.

Although we have taken a rather conservative view of the application of demographic projections to educational projections, our analysis still leads us to predict substantial increases in SES activity, both in the first 5-year period and over the 10-year period

as a whole. If the increases do not occur, our recommendations should be scaled down accordingly. At the dire extreme -- that is, in the case of a significant absolute reduction in SES graduate activity -- it might conceivably become necessary to envisage an actual reduction in the number of SES graduate departments, in order to avoid general dilution of the whole system and the inevitable inclusion of several very weak units.

SECTION 2: THE PRESENT ONTARIO SES SYSTEM

2a. Institutions and Faculty

We now consider the present configuration of the Ontario SES system. Our description will apply to the academic year 1971/72, since this is the latest year for which we have complete data.

Ontario supports fourteen degree-giving universities, of which twelve universities have some undergraduate solid earth science programmes. M.Sc. programmes, or the equivalent, in at least one solid earth science discipline are offered in ten of the universities, and seven of the universities offer Ph.D. programmes.

Faculty totals for the SES system, as reported to us, range from as high as 224 to as low as 186. The higher total includes faculty at all SES centers, undergraduate teachers in addition to graduate teachers, and some individuals who work on an honorary basis or on very restricted time. Some of the 224 cannot be described as making a research contribution to the SES system (although they may well be active in research outside the system). The lower total of 186 more immediately concerns us. It relates to the graduate centers, plus SES faculty at non-graduate centers who have returned themselves as spending time on research. The total of 186 is made up of 24 part-time and 162 full-time faculty. Assuming two part-timers to equal one full-timer, then 174 (162 + 12) FTE faculty expend, according to their own estimates, the equivalent of 82 FTE on research and graduate instruction (Table 2.1). That is to say, the average full-time faculty member in SES expends 47% of his time on the activities indicated. If the SES faculty are typical of university in general -- then their average workweek is about 50 hours, as is borne out by a number of university studies; and their typical work-year, for full-time appointees, is eleven months.

The SES consultants have wondered if the percentage estimates of research and graduate-instructional time, on which Table 2.1 is based, may not be somewhat on the high side in some individual cases. Nevertheless, an average of 23½ hours a week on research and graduate instruction through the year, inciuding for many the field season, does not seem unreasonable; and we know that some SES faculty average far more than a 50-hour work-week.

Table 2.2 recalculates the data on Table 2.1 in the form of percentages for the system. Either Table 2.1 or Table 2.2 can be

Table 2.1 RESEARCH AND GRADUATE INSTRUCTION ACCORDING TO SUBDISCIPLINE (1971/72). The figures represent FTE Faculty. Source: Departmental returns to ACAP Consultants

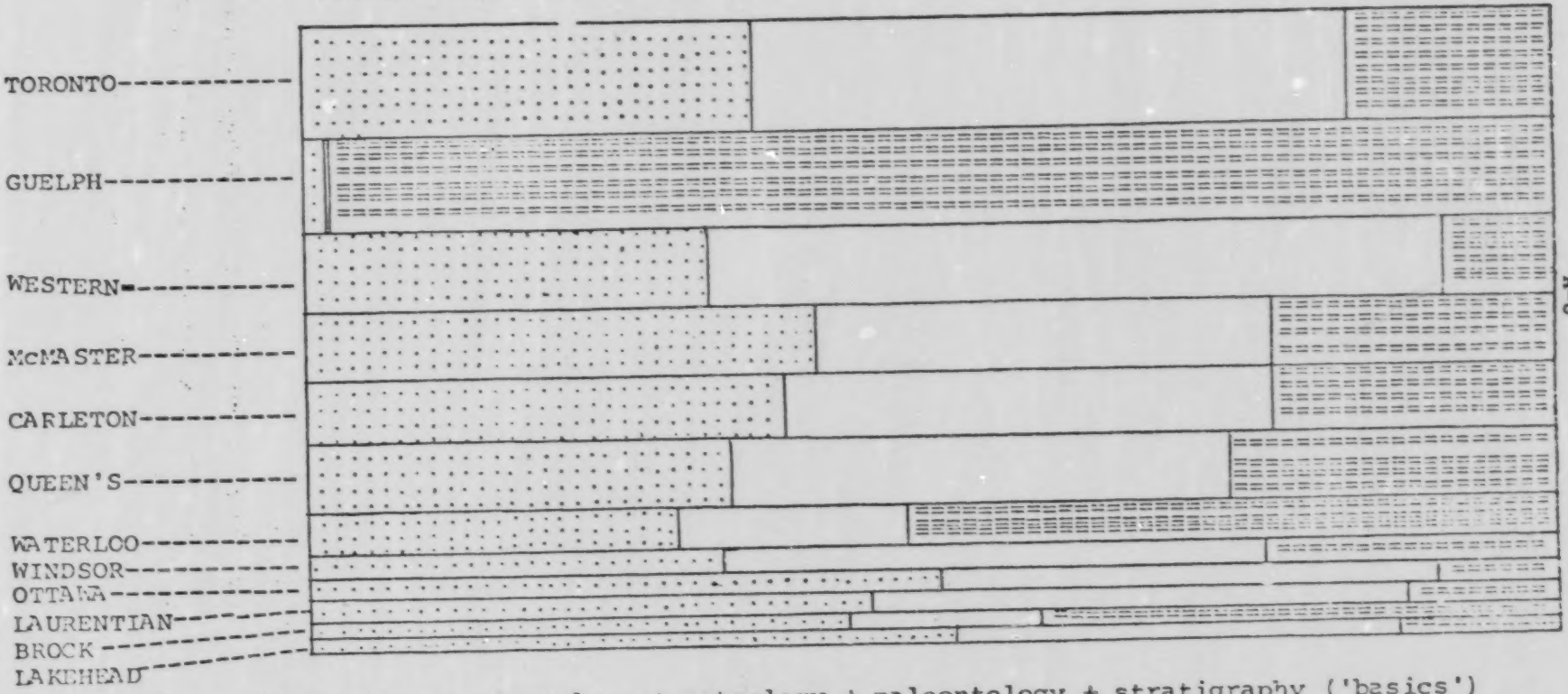
	BROCK	CARLETON	GUELPH	LAKEHEAD	LAURENTIAN	MCMASTER	OTTAWA	QUEEN'S	TORONTO	WATERLOO	WESTERN	WINDSOR	TOTALS
ECON. GEOL.	0.025	0.880	.....	0.210	0.475	0.641	0.013	0.705	1.048	0.420	0.830	0.460	5.707
ENGG. GEOL.	.....	1.175	0.080	.....	.....	.....	.....	0.320	1.213	0.300	0.500	0.150	3.738
ENVIR.GEOL.	0.160	0.120	.....	0.100	.....	0.275	0.250	0.356	0.250	1.608	.....	.....	3.119
GEOMORPH.	0.675	0.480	1.220	0.100	0.300	1.665	.....	0.970	0.850	1.270	0.360	0.515	8.405
PEDOLOGY	.....	0.060	10.750	.....	.....	0.240	.....	0.510	0.175	.....	.....	.....	11.735
SEDIMENTOL.	0.100	0.720	0.120	0.400	0.400	1.385	0.464	0.275	0.845	0.440	0.278	0.425	5.852
MINERALOGY	0.370	0.750	.....	0.250	.....	0.841	0.125	0.786	0.900	0.100	0.957	.....	5.079
PETROLOGY	0.080	0.840	0.090	.....	0.300	0.486	0.588	0.860	1.330	0.225	0.916	0.240	5.955
STRATIGRAPHY	0.170	0.200	0.045	0.135	0.100	0.120	0.125	0.495	0.817	0.620	0.831	0.155	3.813
PALEONTOLOGY	0.150	0.680	0.045	.....	0.400	0.760	0.125	0.362	1.650	0.420	0.240	0.150	4.982
STRUCTL.GEOL.	0.030	0.990	.....	0.225	0.300	0.228	0.650	0.575	0.410	0.150	0.463	.....	4.021
GEOPHYSICS	0.030	0.280	.....	.....	0.100	0.252	.....	0.750	3.570	.....	3.810	0.345	9.137
GEOCHEMISTRY	0.240	1.070	0.045	0.120	0.300	2.037	0.444	1.111	2.290	0.600	1.006	0.350	9.613
MARINE GEOL.	.....	.....	.....	.....	.....	0.190	0.043	0.155	0.123	.....	.....	0.120	0.631
TOTALS	2.030	8.245	12.395	1.540	2.675	9.120	2.827	8.230	15.471	6.153	10.191	2.910	81.787

Table 2.2 RESEARCH AND GRADUATE INSTRUCTION ACCORDING TO SUBDISCIPLINE (1971/72)
Expressed as % of system total. Source: Departmental returns to ACAP SES Consultants

	BROCK	CARLETON	GUELPH	LAKEHEAD	LAURENTIAN	McMASTER	OTTAWA	QUEEN'S	TORONTO	WATERLOO	WESTERN	WINDSOR	TOTALS
ECON. GEOL.	0.031	1.076	.....	0.257	0.581	0.784	0.016	0.862	1.281	0.514	1.015	0.562	6.979
ENGG.GEOL.	.....	1.437	0.098	.....	.....	.....	.....	0.391	1.483	0.367	0.611	0.183	4.570
ENVIR.GEOL.	0.196	0.147	.....	0.122	.....	0.336	0.306	0.435	0.306	1.966	.....	.....	3.778
GEOMORPH.	0.825	0.587	1.490	0.122	0.367	2.036	.....	1.186	1.039	1.553	0.440	0.630	10.275
PEDOLOGY	.....	0.073	13.145	.....	.....	0.293	.....	0.624	0.214	.....	.....	.....	14.349
SEDIMENTOL.	0.122	0.880	0.147	0.489	0.489	1.694	0.567	0.336	1.033	0.538	0.340	0.520	7.155
MINERALOGY	0.452	0.917	.....	0.306	.....	1.028	0.153	0.961	1.100	0.122	1.170	.....	6.209
PETROLOGY	0.098	1.027	0.110	.....	0.367	0.594	0.719	1.051	1.626	0.275	1.120	0.293	7.280
STRATIGRAPHY	0.208	0.245	0.055	0.165	0.122	0.147	0.153	0.605	0.999	0.758	1.106	0.190	4.663
PALEONTOLOGY	0.183	0.831	0.055	.....	0.489	0.929	0.153	0.443	2.017	0.514	0.293	0.183	6.090
STRUCTL.GEOL.	0.037	1.210	.....	0.275	0.367	0.279	0.795	0.703	0.501	0.183	0.566	.....	4.916
GEOPHYSICS	0.037	0.342	.....	.....	0.122	0.308	.....	0.917	4.366	.....	4.659	0.422	11.173
GEOCHEMISTRY	0.293	1.309	0.055	0.147	0.367	2.491	0.543	1.358	2.800	0.734	1.230	0.428	11.755
MARINE GEOL.	.....	.....	.....	.....	.....	0.232	0.053	0.190	0.150	.....	.....	0.147	0.772
TOTALS	2.482	10.081	15.155	1.883	3.271	11.151	3.458	10.062	18.915	7.524	12.460	3.558	100

Some 31.4% is concentrated in Sedimentology+Mineralogy+Petrology+Stratigraphy+Paleontology
Some 35.6% is concentrated in Economic geol.+Structural geol.+Geophysics+Geochemistry + Marine Geology
Some 33.0% is concentrated in Engineering geol.+Environmental geol.+Geomorphology + Pedology

Figure 2.1 FTE Faculty on Research and Graduate Instruction, Ontario SES System, 1971/72: Distribution Among and Within Universities.
Thickness of bars is proportional to total reported faculty numbers.
Source: Departmental returns.



Stipple: sedimentology + mineralogy + petrology + paleontology + stratigraphy ('basics')
Open: economic geol. + structl. geol. + geophysics + geochemistry + marine geol.('applications'
Hatched: engg. geol. + envir. Geol. + geomorphology + pedology ('landscape management')

regarded as the basis of Fig. 2.1, which can be taken as a good approximation to the gross distribution of research and graduate instructional strength through the system, as aggregated from individual returns. The grouping into basic, applied, and management fields is as debatable as the original classification into subdisciplines; but, simply because it is more broadly based, it may give a more accurate picture, both of the whole and of the parts. As might be expected, the older and larger centers, Toronto, McMaster, Carleton, and Queen's display something of a balance among the three groups distinguished, although geophysics extends the applied group at Toronto, as it notably does at Western. Guelph, here as throughout, is a somewhat special case, with very heavy emphasis on the management field. Waterloo's interest in groundwater geology is reflected by a large proportion of management activity, as also is the quaternary interest at Brock. The remaining smaller centers understandably have prominent interests in the basics.

In this broad view, the various centers constitute a varied array, with specialisms and subspecialisms clearly implied even in a summary. As we shall be reporting later, there is scope for variety to increase still further.

The range of faculty research interests contrasts with a marked demographic clustering. Of the 224 SES faculty in the maximum list, some 75% (157) were 45 years of age or younger at the end of 1972, some 50% (116) were 40 years of age or younger, and some 25% (61) were 34 years of age or younger. This set of circumstances reflects, among other things, the rapid expansion of the 1960's. While the prospect of a generally sound, lively, and vigorous faculty for the system as a whole is encouraging in one sense, it suggests reservations for the future. If departure from the system were by retirement at age 65 only, then only 6 SES faculty would be leaving by the end of our first 5-year period, that is, by the end of 1977/78, and only another 7, making 13 in all, by the end of the ten-year period at the close of the 1982/83 year. The reputation of some units or sub-units rests heavily on the work of individual scholars in the higher age-ranges. The high proportion of younger faculty means that most reputations have yet to be made. If SES enrolments should stabilize, and if in consequence faculty recruiting (except for turnover) should become very restricted, then some units could in the future develop problems of deferred promotion and of intellectual stagnation.

2b. Graduate Students

Graduate enrolments in the SES system rose from about

240 in 1967/68 to about 400 in 1971/72 [1] (Table 2.3). The 1971/72 total included some 220 full-time & part-time master's students, and some 170 full-time or part-time doctoral students. Regression of stretched data gives about 2.1 graduate students per FTE faculty member (Fig. 2.2). There is a small positive correlation between graduate student/faculty ratio and size of department, but the variation resulting is small for the system as a whole.

Of the graduate student population, about 40% are registered in Ph.D. programmes, and about 60% in Master's programmes. The flow of students through the system is illustrated in Table 2.3 and in Figs. 2.3 and 2.4. From these data, it appears that the residence time in Ph.D. programmes is between 3½ and 4 years, and in a Master's programme about 3 years. We have used for our projections a residence time of 4 years for Ph.D. work, although there is background evidence that in some university systems the rate of throughput is increasing and the residence time accordingly decreasing. The Ontario SES system in 1971/72 produced 44 Master's and 33 Ph.D.'s.

Of the students enrolled, about two-thirds of the Master's candidates are Canadian citizens, and about one-third of the Ph.D. candidates are Canadian citizens (Table 2.4, Fig. 2.5). Of the "non-Canadian" students, a substantial and growing proportion come from Great Britain and the U.S.A. We shall argue later that these proportions are not unreasonable.

Upon graduation, these students seem readily employable. For all Ph.D.'s graduated in Canada in 1971/72, for all disciplines, only 3% were not employed within six months of graduation (see Table 2.5). For the Ontario solid earth science system, we located only two unemployed Ph.D.'s or ABD's for the period of the data supplied by the universities (Table 2.6); that is, an unemployment proportion of only 1.4%. Table 2.6 also demonstrates that more than half the SES Ph.D.'s have been absorbed by industry and government; the market situation contrasts strongly with that of most other fields of study.

We had highly informative discussions with graduate students. Although we hope that this report in general takes

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[1] In this, as in some other connections, absolute precision cannot be achieved. The ACAP Research Unit reports a similar experience. Discrepancies arise from the irregular supply of data, from some minor conflicts in the returns, and from corrections made from time to time. However, discrepancies in the graduate student data that we use are unlikely to exceed 1% of a given total, and have no effect on our conclusions and recommendations.

Figure 2.2 Ratio between graduate enrolments and faculty numbers, Ontario SES system.

Sources: ACAP Research Unit, system data for 1967/68 through 1971/72
CUDG(O) Report, geology and geophysics data, 1956-67

For the ACAP data (geology + geophysics + physical geography),
$r = +0.961$, $r^2 = 0.924$, $0.001 > P$.
The graph is fitted to the whole set of data.

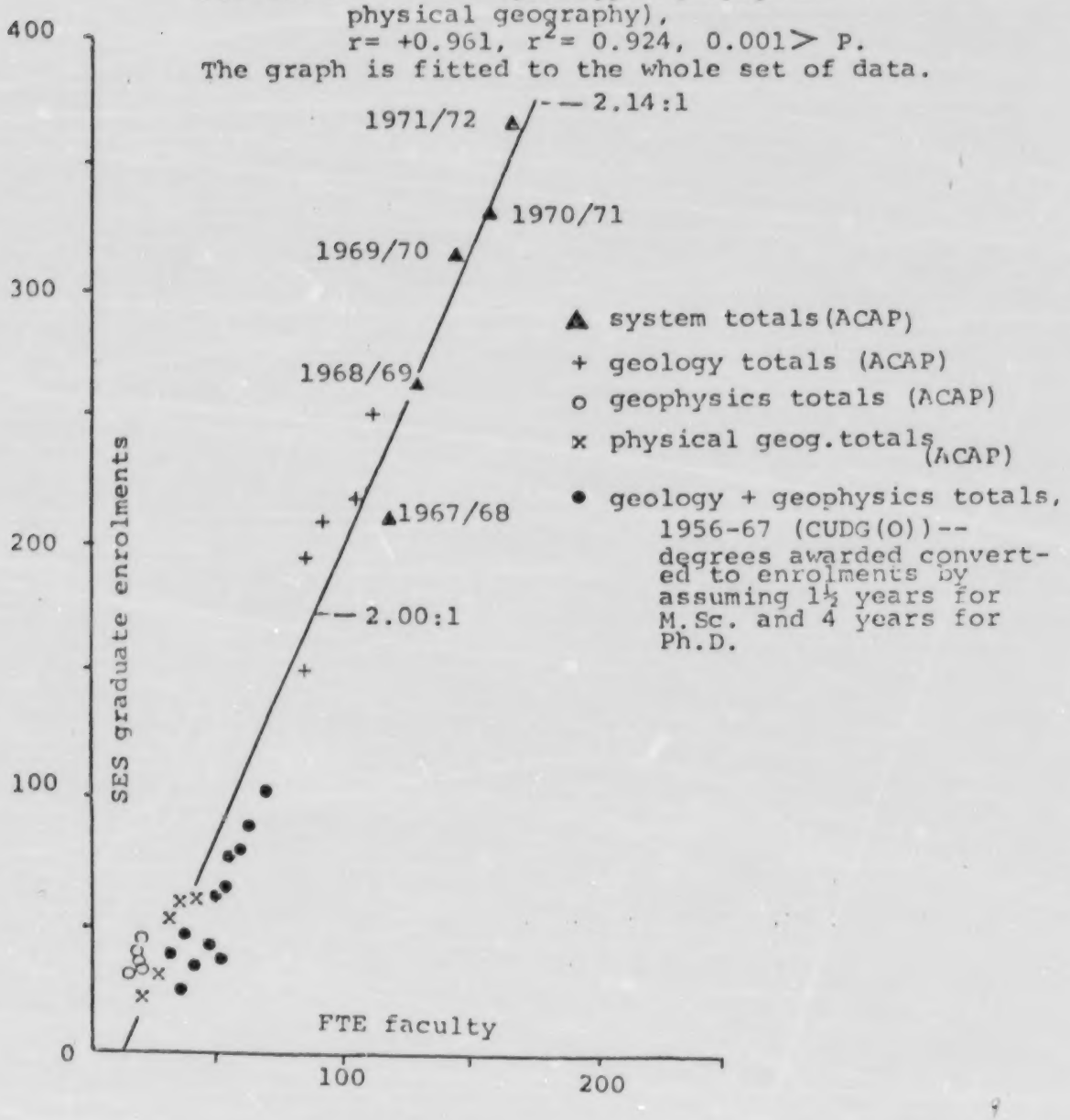


Table 2.3 BREAKDOWN OF ONTARIO SES GRADUATE ENROLMENT AND Ph.D.EMPLOYMENT, 1967/68 through 1971/72. Source: ACAP Research Unit data, ultimate base Departmental returns.

		1967/68	1968/69	1969/70	1970/71	1971/72	1972/73
1.	Masters' FT	100	129	145	159	176	
2.	PT	13	18	35	34	44	
3.	Total	113	147	180	193	220	
4.	Continuing		81	103	131	125	166
5.	New entries		66	77	62	95	
6.	Drops	6	3	10	13	8	
7.	Awards	26	41	39	55	46	
8.	Total Outgo	32	44	49	68	54	
9.	Doctors' FT	121	141	154	150	145	
10.	PT	4	18	16	25	26	
11.	Total	125	159	170	175	171	
12.	Continuing		94	136	134	145	134
13.	New entries		65	34	41	26	
14.	Drops	12	6	8	7	4	
15.	Awards	19	17	28	23	33	
16.	Total Outgo	31	23	36	30	37	
Ph.D.Employment							
	Ontario	4	2	6	8	12¢	
	Rest of Canada	9	5	8	6	8	
	Other	8*	10	15*@	9	13@	
Employmt.status as of		1Jan70	1Jan71	1Jan72	immed.	immed.	

For a given year, continuing (lines 4,12) = prev.year enrolment (lines 3,11) less outgo (8+16). New entries (lines 5,13) = total enrolment (lines 3,11) less continuances (lines 4,12).

* Discrepant totals, not resolved by ACAP Research Unit: total employment 1967/68 PhDs = 21, against 19 awards; 1969/70, 29 employed, 28 awards.
@ 4 unknown, 69/70; 2, 71/72.
¢ includes 2 unemployed.

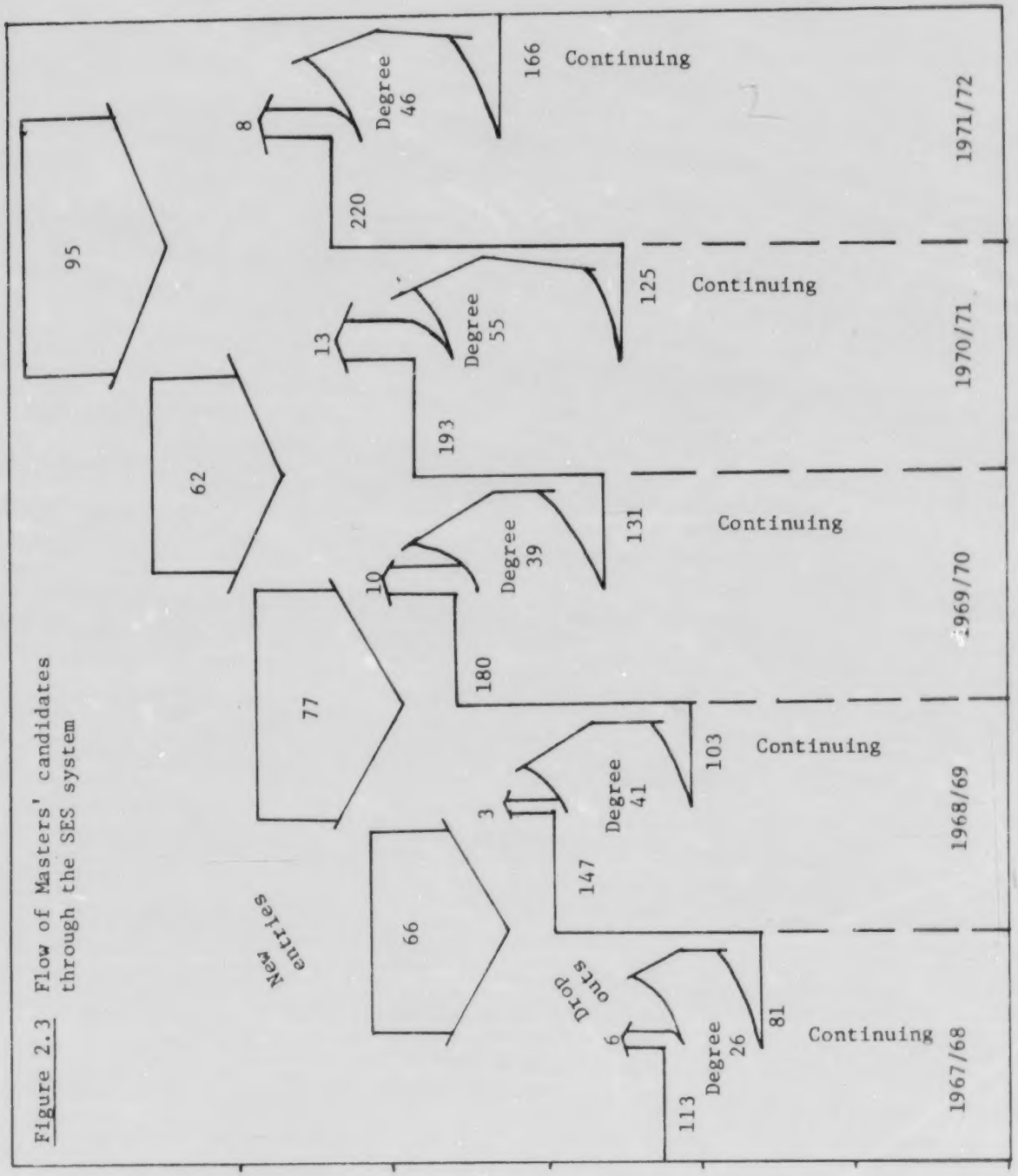


Figure 2.3 Flow of Masters' candidates through the SES system

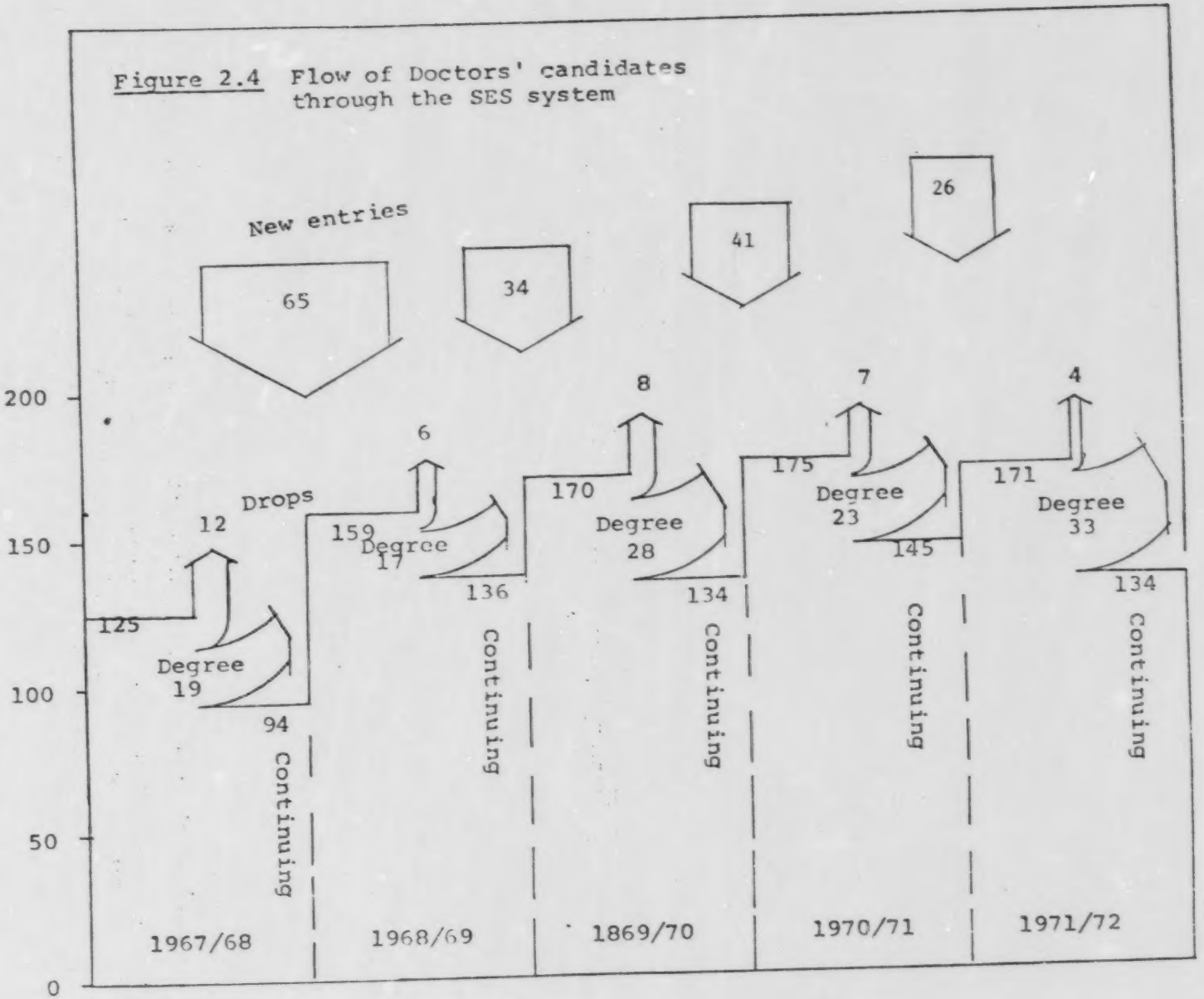


Figure 2.4 Flow of Doctors' candidates through the SES system
New entries
65
34
41
26
200
150
100
50
0
125
12
Degree 19
Drops
94
Continuing
159
6
Degree 17
136
Continuing
170
8
Degree 28
134
Continuing
175
7
Degree 23
145
Continuing
171
4
Degree 33
134
Continuing
1967/68
1968/69
1869/70
1970/71
1971/72

Table 2.4 GRADUATE STUDENT CITIZENSHIP, SES SYSTEM, 1967/68 to 1971/72. Source: ACAP Research Unit data.

		67/68*	68/69*	69/70	70/71	71/72
Canadian Masters'	FT	56	77	90	95	112
	PT	11	15	25	22	29
Non-Canadian Masters'	FT	44	52	55	64	64
	PT	2	3	10	12	15
Canadian Doctors'	FT	38	50	58	57	55
	PT	3	8	7	13	8
Non-Canadian Doctors'	FT	84	91	96	92	90
	PT	1	10	9	11	18
% total Masters' Canadian		59.3	62.5	64.0	60.3	64.0
% total Doctors' Canadian		32.7	36.5	38.2	40.5	36.5
Origin of Non-Canadian Masters'	USA	3	3	6	12	15
	UK	11	15	24	25	27
	ASIA	15	16	14	10	9
	OTHER	16	21	17	23	25
Unknown		1	...	...	1	...
Landed immgt, Canad.bachlr, or student visa		...	...	4	4	4
Origin of Non-Canadian Doctors'	USA	14	16	19	18	16
	UK	22	26	24	28	30
	ASIA	27	28	24	23	23
	OTHER	20	30	37	32	36
Unknown		1	1	...	...	...
Landed immgt, Canad.bachlr, or student visa		...	...	1	2	3

* For 1967/68 and 68/69, Country of first degree has been used as a measure of citizenship, but resulting discrepancies are slight.

Figure 2.5 Graduate Student Citizenship, SES System Total. Source: ACAP Research Unit data. For 1967/68 and 1968/69, country of first degree other than Canada assumed to mean non-Canadian. Throughout, non-Canadians include landed immigrants. Discrepancies produced in these two ways are small.

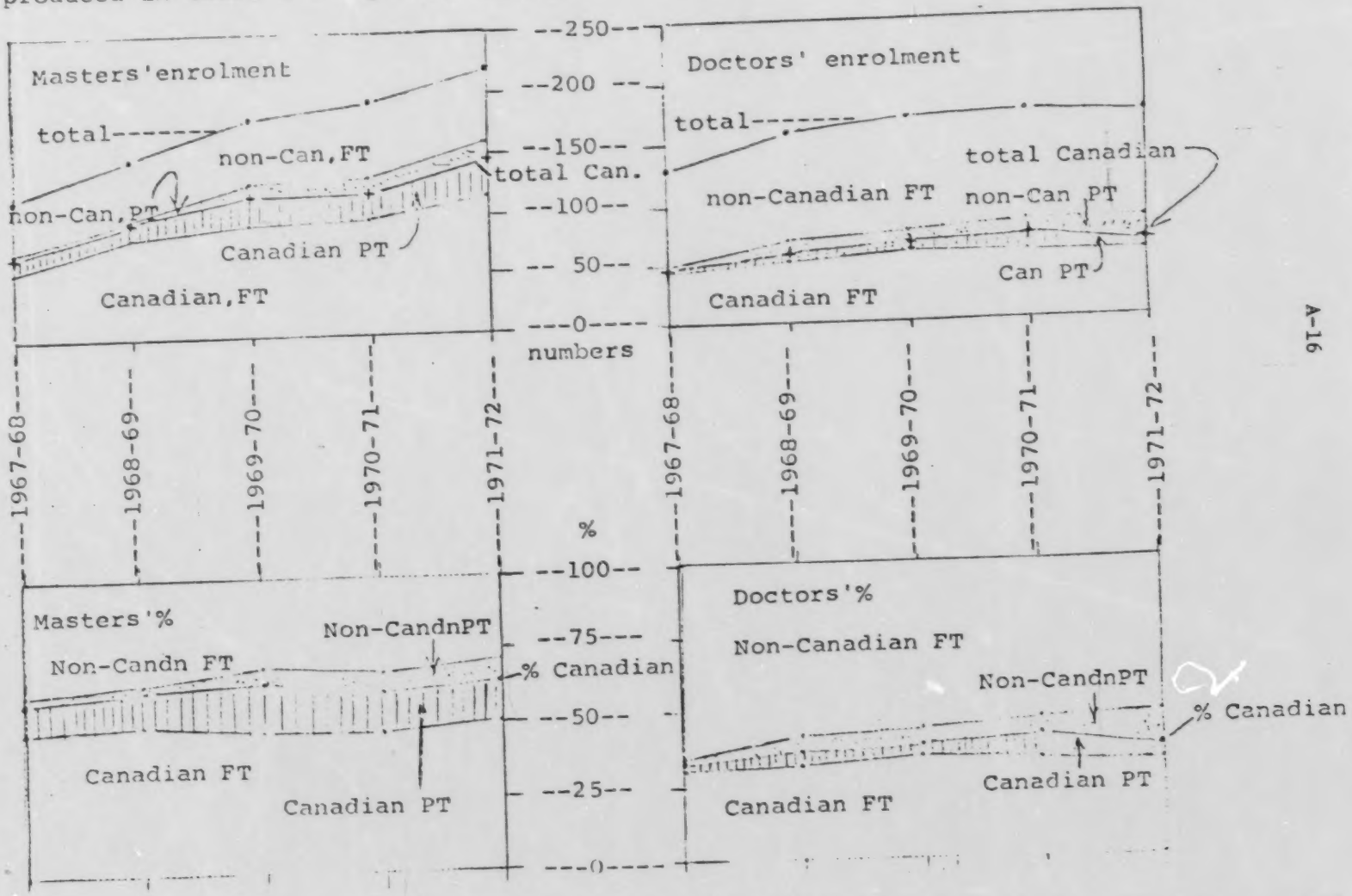


Table 2.5 EMPLOYMENT OF CANADIAN PhDs
Source: CAGS

Employer	1970/71	1971/72
University	40%	38%
Industry	9%	9%
Fellowships	28%	28%
Research Institutes	3%	4%
Government	9%	8%
Unemployed	5%	3%
Other	6%	10%
Total number	1314	1396

Table 2.6 EMPLOYMENT OF ONTARIO SES PhDs, 1967 to 1972 (data include ABDs). Source: ACAP Research Unit

Employer	Number	Per cent
University	35	25.4
Industry	42	30.4
Government	30	21.8
Colleges, High Schools	0	0.0
Fellowships	20	14.5
Research	2	1.4
Other	1	.7
Unemployed	2	1.4
Unknown	6	4.4
Totals	138	100.0

proper cognizance of the students' views, we should like to record here a few of the stronger statements made by them. In presenting their views, the students seemed to be responsible and knowledgeable.

The students at several universities, notably Toronto, Queen's, and Ottawa, believe that there is a clear shortage of jobs for Ph.D.'s in the solid earth sciences. At Queen's, we encountered a belief that faculty members underestimate the problems of students in this regard. At Toronto, among other places, the students were inclined to view their own fields rather narrowly, and admitted that this circumstance contributes to employment difficulties.

The students accept the proposition that limited financial resources may require limited enrolment. This view, expressed by students at Toronto, Queen's, Ottawa, and Carleton, was accompanied by thoughtful statements about the means of limiting enrolment. Generally, graduate students believe it is morally wrong to reduce enrolment by squeezing the financial support of individuals. Rather, reduction should be achieved through some form of direct quota. In their view, selection should be based solely on academic criteria, and arrived at in a way that would provide at least a minimum level of guaranteed support.

Graduate students frequently expressed the view that major facilities may be inadequate, or not readily available to themselves. We had this view from graduates at Ottawa, among the older institutions. It was their opinion that cooperation with government scientists, although often good, relies too often on chance; and that students fare particularly well if their supervisors have been employed by, or otherwise closely associated with, the Geological Survey of Canada. Far more often than faculty members, graduate students recognized a need and a place for extra-departmental contacts and courses. Numbers of geology graduates at a number of centers judged themselves inadequately prepared to take advantage of the techniques of mathematics, physics, and chemistry; some consider that their lack of preparation is not fully recognized by their SES faculty.

In relaying these opinions, we are conscious that the student groups that we met constituted biased samples. The proportion of the graduate student body encountered by us varied from center to center; and the degree of dominance in discussion by one or a few graduates varied similarly. We believe, however, that we have discounted most opinion bias, and we remain impressed by a common core of concern in the SES graduate population as a whole.

2c. Undergraduate Base and Department Status

Throughout the province, we observed an undergraduate base that is in the main adequate, or if not yet adequate, then broadening. It is very difficult to give system tabulations, because the identification of majors students occurs at varying times in the programme and they are rarely classified according to

Figure 2.6 Numbers of First Year Undergraduates and Numbers of FTE Faculty, Geology and Geophysics, 1970/71 and 1971/72. Source: CUDG(O) data. (There is no significant difference between the two years).

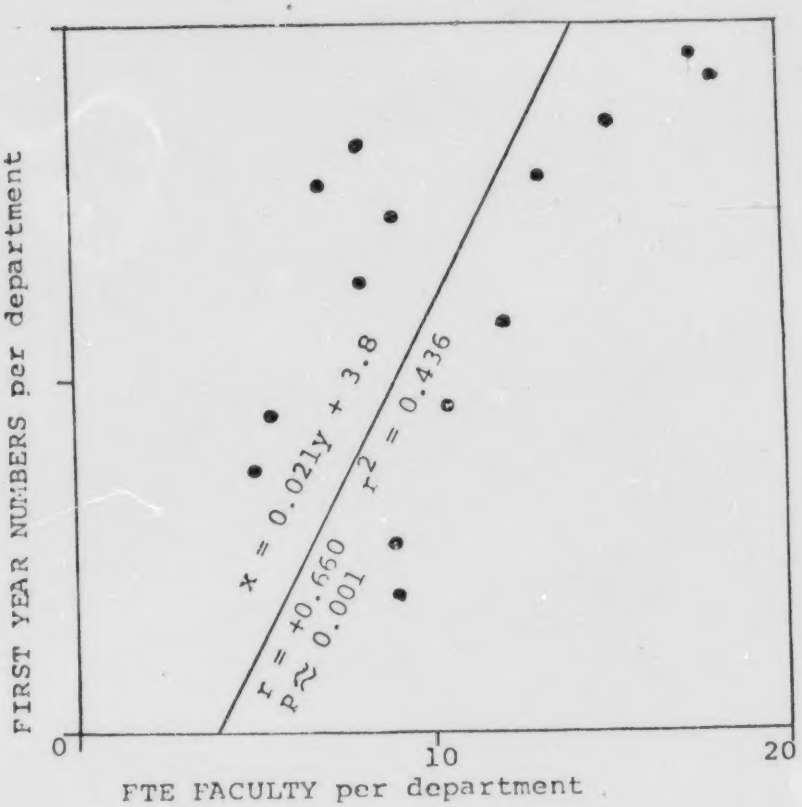


Figure 2.7 Numbers of 2nd, 3rd, and 4th Year Undergraduates and Numbers of FTE Faculty, Geology and Geophysics, 1970/71 and 1971/72. Source: CUDG(O) data. (There is no significant difference between the two years).

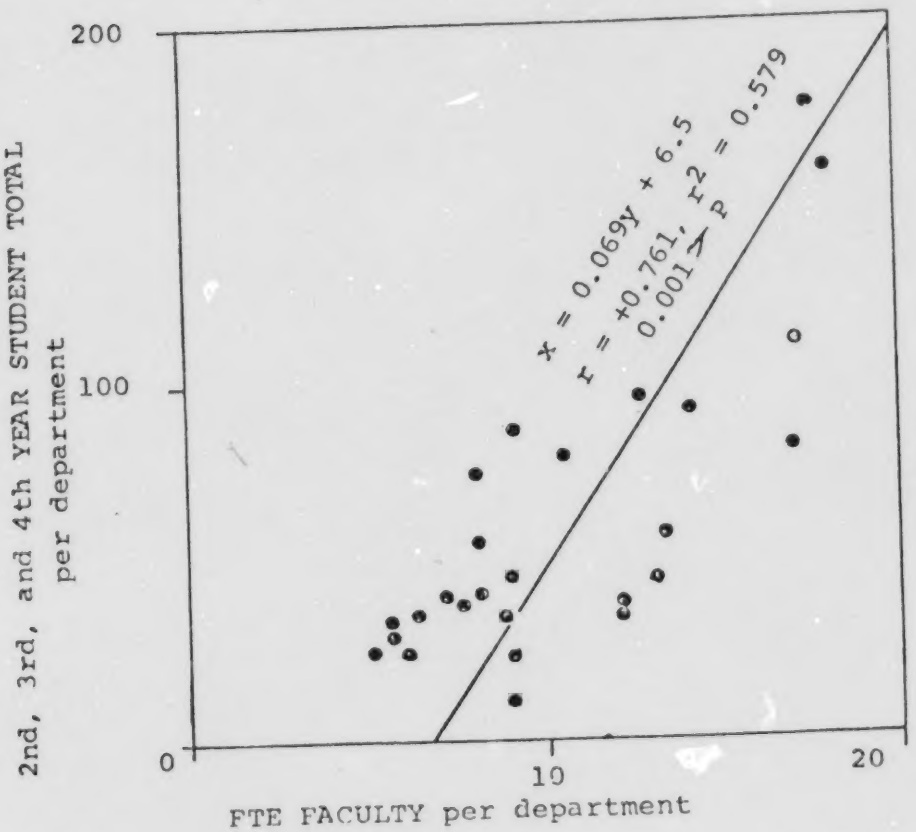
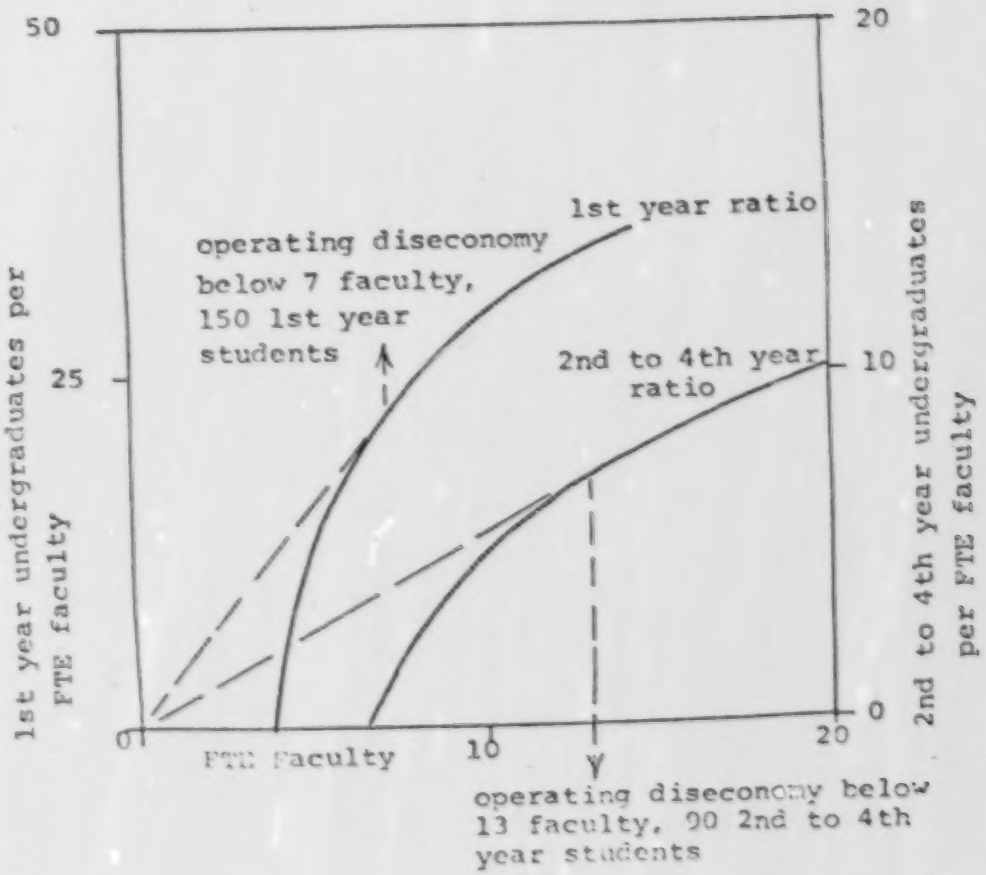


Figure 2.8 Student/FTE Faculty ratios, plotted for the equations in Figs. 2.6, 2.7. Ultimate source: CUDG(O) data.



the sub-disciplines we use. As is true elsewhere, a substantial proportion of teaching in the first two years is service teaching for other disciplines.

Figures 2.6 and 2.7 show regressions of student numbers against faculty numbers for geology and geophysics. Strong correlations emerge particularly for higher level students. We wish to emphasize that this analysis describes the system as it now exists. When the graphs of Figs. 2.6 and 2.7 are re-drawn to show student/faculty ratios on arithmetic scales, they suggest that diseconomies of operating scale set in where faculty numbers are low and where low student numbers reduce the student/faculty ratio (Fig. 2.8).

One underlying reason for the low student/faculty ratio in small departments is that, to begin operating at all, a department needs more than one faculty member. Another and allied reason is that, in the new institutions, the development of courses and of power to attract undergraduates lag behind the initial appointment of faculty. The older departments, in populous universities, are able to achieve economy of operating scale by means of large undergraduate classes, including considerable groups of declared majors.

We are very reluctant to use our descriptive data to construct a model for the future. Also, we do not regard an undergraduate base alone as a justification for the initiation of a graduate program. Conversely, the lack of a large undergraduate base could result from the late declaration of the major (for example, not until the fourth year in geophysics at Toronto), or from the ability of a particular graduate school to attract graduate students from elsewhere.

Solely for the purpose of describing the present situation, we suggest that operating diseconomy in first-year teaching sets in where faculty numbers fall below 7 and first-year enrolment falls below 150; and that operating diseconomy in second to fourth year teaching sets in where faculty numbers fall below 13 and the tally of declared majors fall below 90 (Fig. 2.8). But the apparent diseconomies set in slowly at first. An hypothetical full-fledged undergraduate department might reasonably aim at 10 or more faculty members, 300 or more first-year undergraduates, and 50 or more declared majors in second to fourth years.

The classification and reporting of first-year enrollees is so variable that we should prefer the declared major total, if we had to select a single index. Data reported to us for undergraduate enrolments in geology and geophysics for 1972/73 suggest that Brock, Carleton, McMaster, Queen's, Toronto, Waterloo, Western, and Windsor have adequate undergraduate bases in geology, or in geology and geophysics combined, either in the major years or in these plus the first year (we are leaving the Guelph Land Resources operation out of this part of the discussion). There are also considerable undergraduate totals at Lakehead. Ottawa, with perceptible but still rather modest undergraduate numbers, is dealt with

by our later recommendation on the Carleton-Ottawa combination.

We have already recognized that a new department is likely to develop through a less than optimal condition of operating economy; and we consider that its development could be spread through a considerable period of time. At this juncture, we wish to dissent from some of the criteria of development that can be read into the CUDG(O) Report. The authors of that Report appear to have used analysis, similar to our own analysis of unit populations, to infer that particular sizes of department are related to particular levels of operation -- undergraduate, master's and doctoral: that is to say, that about 7 faculty are necessary (or adequate) for undergraduate work, about 9 for a master's programme, and about 11 for a doctoral programme. We are familiar with the concept of critical mass, and know that a minimum mass of 5 is often mentioned in the research context. However, we regard the 7-9-11 scale as involving dangers of two kinds. On the one hand, it could conceivably be used to deny faculty expansion to a department with a master's programme and 9 faculty, on the ground that faculty numbers are already sufficient. On the other hand, the scale might be used by a department of given size, but with no great intellectual strength, to lay claim to graduate operations. As we have shown, the hypothetical department with a full-fledged undergraduate programme, and with a master's and a doctoral programme in addition, could expect at existing levels of operating efficiency to have 10 or more FTE faculty, and could be expected to have 20 or more graduate students. A general increase in student and faculty populations should eliminate the slight apparent diseconomies of operation in the upper range of Fig. 2.8, and could involve for instance an increase in the student/faculty ratio to more than 2:1.

2d. Facilities

It is difficult for outsiders to determine whether or not the solid earth sciences are getting a fair share of science space on each campus. This matter has been commented upon by CUDG(O). We consider a continuing review of allocation procedures to be desirable, in order that equity with the other sciences be established. We occasionally encountered an administrative view that physical requirements for solid earth sciences should be less than for other laboratory sciences, because of the emphasis of SES on field research. This view is completely indefensible. In fact, field work demands additional specialized facilities to support off-campus operations.

We were greatly impressed by the attractive and well-designed buildings at several of the emerging campuses. On the other hand, some of the space assigned to some other departments is unacceptable. For example, the geology and geomorphology space at the St. George campus of the University of Toronto is inadequate, depressing, and antiquated. A similar comment could be made for some of the geomorphology space at Guelph. At some

other places, we observed crowding and/or scattering of space facilities. We did not sense under-utilization of assigned space in any of the departments we visited.

The system as a whole appears to be very well provided with major equipment and library resources. However, we are not wholly certain that equipment is correctly distributed or sufficiently accessible to potential users. We were impressed by the functional way that microprobe laboratories have been established, and observe the enthusiastic acceptance of these facilities by SES faculty and students. On the other hand, the mass spectrometer, with comparable potential for SES research, and of comparable cost and complexity, has not been accepted by the majority in the same way. We relate this circumstance, at least in part, to the fact that the facilities are not appropriately engineered or staffed. While aware that similar criticism can be levelled at many similar facilities outside Ontario, we feel bound to comment that this specific criticism is part of a general criticism: the SES facilities in the system as a whole deserve, and could effectively use, more technical, maintenance, and backup staff than are currently provided. Furthermore, our recommendation for increases in user time implies increase in support staff.

We recognize that the autonomy of institutions and of individual researchers must be preserved. At the same time, we feel that the Ontario SES system has a unique potential to give leadership in the effective use of resources. Funding for the acquisition of major new equipment should be considered in the context of the system as a whole, with due regard to access and use for workers from centers throughout the Province. It is desirable that these considerations should apply equally to equipment in government laboratories.

A summary of library resources (Table 2.7) indicates that the system is adequately served in terms of library holdings. We commend the Ontario universities for the excellent arrangements that have been made for access of books and periodicals throughout the Province.

SECTION 3: ROLE OF THE ONTARIO SES SYSTEM

3a. Role Within the University

The role of solid earth science in the university is no different from the role of any other component of the university structure. Broad aims and general responsibilities are the same -- that is, the enhancement of understanding, the establishment of truth, and the communication of knowledge and truth to students and society; and, in addition, the provision to society of a resource of trained people.

The universities alone are charged with the unique

Table 2.7

LIBRARIES, 1970-71 DATA

SOURCE: DEPARTMENTAL RETURNS

	1970-71 Funds	L.C. Monographs & Serials	1970-71 Acquisitions	Total Serials	Total Serials Currently Rec'd	Notes
BROCK	$ 5,297	1,187	222	66	58	Started 1968 (Private Members' libraries)
CARLETON	5,300	2,573	373	92	89	G.S.C. library available
GUELPH	11,428	2,034	715	89	83	
LAKEHEAD	8,400	1,375	550	78	68	5 years a-building
LAURENTIAN	3,000	944	188	81	71	
MC MASTER	27,000	2,448	1,537	90	83	
OTTAWA	8,545	1,778	102	79	72	G.S.C. library available
QUEEN'S	19,100	5,505	1,301	97	94	
TORONTO	N/A	5,508	N/A	107	100	
WATERLOO	8,728	5,218	332	96	95	Funds, 1969-70: $15,613
WESTERN	11,140	4,259	240	98	98	
WINDSOR	8,293	1,671	201	89	82	Pre-1960 issues lacking

N/A - Not Available

responsibility of leading the search for truth. It is this special responsibility that distinguishes the university from other institutes of higher learning.

3b. Search for Material Resources

In Canada, the solid earth sciences play a special role in providing expertise and personnel to assist in the exploration for, and the exploitation of, hydrocarbons, industrial minerals, and ore deposits. We recognize that Canada's economy has been based on its natural resources, and we expect that the exploitation of these resources will continue to be an important economic activity in the future. The growth of the economy in general, and of the Canadian manufacturing industry in particular, will only increase the demand for raw materials and for energy sources.

In view of the foregoing, we understand the university to have special responsibilities in solid earth sciences. These include the education of skilled people to contribute to studies of the earth, and to help mankind to interact, in the broadest possible terms, with the earth in a responsible manner. We see the university as having a responsibility to contribute to the understanding of basic earth processes, both for their intellectual value and also for practical purposes of resource discovery and management. We perceive a responsibility to develop new exploration techniques, taking exploration in its broadest possible sense. We believe that the solid earth sciences should undertake missions in the national and provincial interest. Canada should take a position of leadership in these disciplines, commensurate with its rich endowment of resources, its huge extent, and its fine history of accomplishments in the earth sciences.

3c. Social Responsibilities

It is an obvious truth that the disciplines considered in this Report are in the unique position of being the sciences concerned with the earth. Geomorphology is concerned with the broad study of landforms, geology with unravelling earth structure and history, and geophysics with physical earth properties and their measurement. Although all other sciences contribute to a study of the earth in terms of their own specialties, it is the solid earth sciences that assemble the required evidence and provide an integrated interpretation. Those concerned with these sciences are well accustomed to dealing with the time scales involved and with the capabilities of the processes concerned. Being accustomed to regular dealings with chemistry, biology, physics, applied science, and the social sciences, earth scientists are already interdisciplinary in the most real sense. They can be excused a feeling of some astonishment at the recent rediscovery, outside their own areas, of the value of interdisciplinary work.

Of late, attention has been forcibly directed to the

energy budget of the earth and its depletion by modern industrial society. Energy from fossil fuels, like other mineral resources, is finite. The discovery and utilization of future resources will tax our ability to develop and apply new knowledge and techniques. Whether with fossil fuels, hydroelectricity, or atomic energy, the development and utilization of energy resources inevitably involve aspects of direct concern to solid earth scientists.

One can easily think of many other examples where the solid earth sciences have areas of responsibility to society. One thinks, for example, of problems of fluid waste disposal and related perturbations of the environment. One thinks of the geomorphologic and pedological studies required to understand the surface of the earth as it is presented to man. Particularly fashionable at the present time are pollution studies related to water circulation and soil sciences. Finally, we think of the development of the Canadian North, and the continental shelf.

To anticipate comments to come in further sections of this Report, we note that solid earth scientists seem not to have faced up adequately to these particular social obligations. In our visits to the universities, the matter was raised only by graduate students, who pointed out that environmental studies are falling to other science departments no better qualified, and in some respects less well qualified, to deal with the total earth system.

3d. Academic Pursuits

We are absolutely convinced of the value of the solid earth sciences as prime intellectual pursuits. The value of the search for truth is beyond estimation and it is a particular responsibility of the university among postsecondary institutions. Today's broad philosophical questions clearly capture the attention of society, and particularly of young people. The broad concepts and interdisciplinary nature of the solid earth sciences should be able to provide appropriate challenge and intellectual excitement.

3e. Resources

To play the role we have outlined above, we need qualified scientists and appropriate material resources. We need sophisticated facilities and resource support, both financial and technical. The earth science departments are comparatively small, and perhaps politically vulnerable within the university structure. Generally, they live in the shadow of much larger departments of mathematics, physics, chemistry, and biology. However, if the university community is really convinced of the importance of interdisciplinary studies, there is no better way of promoting them than the development of solid earth science departments. Care should be taken that other disciplines do not weaken SES by competing in the

traditional areas of geology, geophysics, and geomorphology. Duplication, even if it can be justified within the university context, could be very costly to the smaller solid earth sciences departments. Finally, it should be recognized that a multidisciplinary laboratory requires instruments and technicians from many specialties, in order to carry out the job it must perform.

SECTION 4: STRENGTHS AND WEAKNESSES

4a. General Comments

The Ontario universities provide a large and diverse solid earth science system. As would be expected of such a system, essentially all subdivisions are represented in some way. Therefore, in this report, we shall limit ourselves to selecting for comment only cases of outstanding strength or weakness, or cases which we consider to be outstandingly important to Ontario or to Canada. Moreover, even within this limited range, we shall not be attempting a total coverage. There is, for example, no purpose in commenting in detail on the Land Resources work at Guelph, which is already long and firmly established. Our terms of reference direct us to attend to possible changes of direction in the future, rather than to comment on what has already been done.

In general, we sense that the Ontario universities are inclined to emulate the prestigious U.S.A./U.K. institutions working in the SES field. This is not surprising, since so many of the faculty members were trained in those countries. Although it is important to have a significant emphasis on the currently fashionable fields of research (often referred to as working "in the forefront of knowledge"), appropriate attention should also be given to those special studies in which Canada can show world leadership and which are required to serve national ends.

A summary of the graduate student research in the various subdisciplines for 1971/72 is given in Tables 4.1 and 4.2.

4b. Assessment

General Statement

One would expect economic geology to be strong in Canada: and we have found it strong in the Ontario SES system. Moreover, it is clear that students, particularly M.Sc. students, recognize the importance of economically-oriented thesis topics. The recognition appears clearly in the lists of thesis titles. We recognize particular strength in economic geology at Queen's, Toronto, and Western; and we concur with the view expressed in the CUDG(O) Report that there is important developing strength in this area at Carleton-Ottawa. On the negative side, we noted

little evidence of concern with economic aspects *per se*. The current energy resource crisis and our inability to analyze this complex issue without foreign consultations clearly indicates the need for programmes in earth science incorporating economics as a major component. Too little effective use is made of geophysical techniques by non-geophysicists and most students with whom we talked were reluctant to consider isotopic measurements to support their research. Interaction with the Ontario Department of Mines seemed minimal, but it is not clear whether this remark should be taken as a criticism of the universities, or as reflecting indifference on the part of the government organization. Interaction with industry seemed rather patchy.

Activities in engineering geology and geotechnique were largely invisible, except for isolated projects, and for the research activities of the civil engineers at Western. Tables 4.1 and 4.2 indicate little student participation in this area. We have stated earlier that the lines of enquiry open to us may have been too few to enable us to learn what is actually going on; nevertheless, while we learned of, and were impressed by, cooperative work performed by a few individuals, we are still left wondering if the field is really underdeveloped in the Ontario SES system. As mentioned earlier, if an effort to survey this field, regardless of departmental affiliation, has not already been made, or at least arranged, we think that a survey should be undertaken as soon as possible. We regard the matter as important, not only in relation to mining and quarrying, but also in relation to Ontario's level of development in the construction industry, manufacturing industry, urban growth and concentration, and transportation. All these items pose their own particular problems of environmental management. We suspect that, in particular, there could usefully be more research activity in the field of urban geology and geomorphology.

Environmental concern seems stronger outside the earth sciences than inside, even when the present-day environmental gimmickry is discounted. We believe that solid earth scientists should be among those most directly involved with environmental matters, many of which relate directly to aspects of geology and geomorphology. We should prefer not to isolate environmental studies under a special subheading; although much more could be done than is at present being done to demonstrate to outsiders that the environment is getting attention from workers in SES.

Aside from the efforts of individuals scattered through the system, we have recognized strong groups of workers in environmental studies for instance at Waterloo (groundwater studies), Guelph (pedologic and related studies), and Brock (quaternary studies). We agree with the graduate students at one university, who commented that environmental problems should receive attention in all SES departments. But, to put an earlier comment in other words, we believe that the study of the environment should be integrated closely with other SES studies, and that it should be seen as a natural application of these.

Table 4.1 DISTRIBUTION OF MASTERS' STUDENTS IN ONTARIO SES SYSTEM, 1971/72
Source: Departmental returns.

	BROCK	CARLETON	GUELPH	LAKEHEAD	LAURENTIAN	McMASTER	OTTAWA	QUEEN'S	TORONTO	WATERLOO	WESTERN	WINDSOR	TOTALS
Econ. Geol.		1			2	2		4	16	1	9		35
Engg. Geol.		6						2					8
Envir.Geol.						2		2	2	7	1		14
Geomorphology		3	4			8	5		1	4	7	5	37
Pedology		1	20			4			2				27
Sedimentology		1			1	8	1	2	2	2	1		18
Mineralogy							1	2					3
Petrology		2				4	3		4	1	4		18
Stratigraphy		4						1		1			6
Paleontology		1				1		1	2	1	2		8
Structl. Geol.		1					1		6				8
Geophysics					1	1		2	14		4		22
Geochemistry		3			1	7	2	4	3	2			22
Marine Geology								2					2
TOTALS		23	24		5	37	13	22	52	19	28	5	228

Note: Some double-counting of students makes the total slightly more than 220.

Table 4.2 DISTRIBUTION OF Ph.D. STUDENTS IN THE ONTARIO SES SYSTEM, 1971/72
Source: Departmental returns.

	BROCK	CARLETON	GUELPH	LAKEHEAD	LAURENTIAN	McMASTER	OTTAWA	QUEEN'S	TORONTO	WATERLOO	WESTERN	WINDSOR	TOTALS
Econ. Geol.		2				2		8	2		8		22
Engg. Geol.		1									2		3
Envir.Geol.											1		1
Geomorphology						14	2		5	1	6		28
Pedology			9			1							10
Sedimentology		1					1	2	1		2		7
Mineralogy						1	1						2
Petrology		4				1	3	7	5		3		23
Stratigraphy						2	3				2		7
Paleontology						1	3	1	3				8
Structl. Geol.						1	5	7	1		1		15
Geophysics						2		1	12		9		24
Geochemistry		1				8		6	5		1		21
Marine Geology													
TOTALS		9	9			33	18	32	34	1	35		171

The comments that we now make on geomorphology and pedology exclude the integrated soil and soil-related work at Guelph. At other centers, we found that facilities vary widely in quality; and, because of the **study of geomorphology in both geography and geology departments,** geomorphology was not always easy to evaluate. At Carleton, geomorphology commands the use of a fine small workshop; geomorphology at Guelph is well equipped, but has its laboratories scattered, and housed moreover in rather poor basement quarters. McMaster geomorphology is well off, both for research and for teaching. Pedology facilities are excellent at Queen's and satisfactory at Western. At Toronto and Ottawa, little indoor or laboratory research is undertaken, and little provision is made for it. Equipment for geomorphology at Windsor is limited and unimpressive, perhaps as a result of uncertainties of research direction. Geomorphology at Brock is integrated into the quaternary studies programme, with excellent teaching facilities and a radiocarbon laboratory.

Sedimentology, stratigraphy, and paleontology are studied at widely scattered centers, and perhaps this is proper. Special application of sedimentology to quaternary studies results in considerable confusion in the use of the various descriptive terms. In particular, it was rather difficult for us to properly appreciate the activities in quaternary studies, except at Brock.

Mineralogy profits from the strong traditions of Peacock's school at Toronto. Of the various subdisciplines, perhaps this is the best equipped in terms of hardware. Especially is this true, since very few graduate students are working in mineralogy. Although it is clear that the Ontario SES system has capacity to train many more students in mineralogy than it now does, we know of no demand for a marked increase. Mineralogy, of course, provides a service to most solid earth science fields, and is therefore a necessary activity at any solid earth science department.

It is clear that experimental work has become an acceptable and important part of petrology, and the combination of petrology and geochemistry seems relatively strong in the system. However, petrologic and geochemical studies involve very substantial capital costs; attempts should be made to rationalize their development. Specifically, one needs the right kinds of hardware without undue duplication. Since geochemistry was born from petrology and mineralogy, it is natural to find that its techniques are required almost everywhere in the solid earth sciences and represent a broad spectrum of interests. There is a clear strength in elemental geochemistry and non-radiogenic isotope geochemistry at McMaster University, and an emerging strength in geochemical exploration at Queen's.

There is a healthy diversity of approach to structural geology throughout the Ontario system. It is well represented everywhere, and we feel that both the field and theoretical approaches to the subject are entirely satisfactory.

Since we only examined the solid earth side of geophysics, we found it difficult to get a balanced view. Historically, the Toronto programmes have provided the basis for the development of geophysics in Canada, supplying strong traditions in applied geophysics which, although weakening, still persist today. As a subdivision of the Department of Physics, geophysics at Toronto has the advantage of a strong background in the physical sciences and a strong undergraduate base, but has the possible disadvantage that collaborative projects with geology, geography, and engineering may be difficult to arrange. The University of Western Ontario has one of the two separate geophysics departments in Canada, and, in common with many geophysics departments, has difficulty in providing itself with an adequate undergraduate base. In general, we observed that geophysics is not being well enough used by students in related disciplines, such as economic geology, structural geology, engineering geology, and so on.

We were discouraged to see so little interest in Ontario's coasts, including its seacoast. We had expected to see plans at least for work on Hudson's Bay, continental shelves, and on the Great Lakes. We are conscious that a few individual studies focus on aspects of the Great Lakes, but these fall far short of what we have in mind. We were told that problems of transportation and logistic support are major deterrents to work on Hudson's Bay, and that Arctic studies, within the Mackenzie Valley or using that valley as a means of access, are far more practicable than studies of Hudson's Bay, including its shorelines. If we have been correctly informed, then we consider the situation regrettable. The port of Moosonee, after all, is in Ontario.

We have been informed that "Ottawa" would restrict federal support for marine geology to coastal universities. This seems to us an unreasonable restriction, considering that transportation difficulties, such as they are, can be readily overcome, and that the seas occupy three-quarters of the surface of the globe. It would seem just as unreasonable to obstruct coastal universities from studying lakes, or philosophy. Geographically, Hudson's Bay is shared among Manitoba, Ontario, Quebec, and the Northwest Territories. The nearest and most accessible SES centers lie in Ontario. Whatever inquiries may have been made by individual centers, we cannot escape the conclusion that the Ontario centers as a group, when they think of marine studies, think only of the Atlantic. As an extension of this criticism, we draw attention to the lack of SES work on physical limnology, for which there is infinite scope in the province.

McMaster, Queen's, Toronto, and Western

These are four mature universities, that offered solid earth science Ph.D.'s before 1950. All are strong in most, if not all, of the solid earth science sub-disciplines. Together,

they represent 52.5% of the provincial university effort in research and graduate instruction, 78.5% of the Ph.D.'s granted, and 63.5% of M.Sc.'s granted. These figures, and the corresponding figures on a university-by-university basis, represent the proportion of the total provincial university effort as provided to us as background data.

Each of these four universities has its own style, and we think that this is a good thing. Although they have a broad competence, they are wise enough not to attempt everything. Within these universities there is at least one faculty member in all subdisciplines with an acknowledged international reputation.

McMaster University:

11% of research and graduate instruction
19% of Ph.D. students
15% of M.Sc. students

The total style of the solid earth science activities at McMaster University is dominated by the interdisciplinary character of the entire university. Although it would be difficult, and perhaps inappropriate, to urge this style on other universities, it does form an excellent and important part of the Ontario system.

In the Department of Geology, it is clear that fields of sedimentology and mineralogy are very strong. It is one of the few very strong centers of paleontology in the province. The University has a conspicuous strength in laboratory studies; we were told that a greater emphasis on field studies is planned and we welcome this.

We saw little sign of geophysics, although there is at least one individual active in this field. Research in the field of both radiogenic and non-radiogenic isotopes has a very strong, long-standing tradition, and is currently receiving special support in the form of a Negotiated Development Grant. There is exceptional strength in elemental geochemistry.

McMaster University impressed us as the outstanding center of geomorphology in the province. It is very well equipped for teaching and research. We observed particular strengths in karst morphology and pedology.

McMaster is among the very few Canadian universities participating in the analysis of lunar materials.

Queen's University:

10% of research and graduate instruction
19% of Ph.D. students
16% of M.Sc. students

The Department of Geological Sciences informed us that they laid great stress on the strength of the undergraduate base for their graduate programmes. It is clear that they have achieved a standard of undergraduate instruction that is quite outstanding. The planning of the departments with which we were concerned sets an example for other universities. We understand that such planning is characteristic of the university as a whole. Strengths were observed in such traditional fields as economic geology, mineral deposits, supported as would be expected by strengths in petrology and mineral geochemistry. We noted an emerging capability in marine geology.

Queen's University is strong in geochemistry, and there is significant activity in the field of exploration geochemistry. We regret the weakness of the geophysics group, which should be strong enough to complement the active geology research. In particular, we sense a lack of scientific leadership among the geophysicists.

We were well impressed with physical geography at this university. Research and graduate instruction represented a good strong spectrum. The group is particularly well equipped for pedological work. We were pleased to see an excellent cooperation between the physical geographers and the geologists.

The University of Toronto:

19% of research and graduate instruction
20% of Ph.D. students
21% of M.Sc. students

This university has some competence in all sub-disciplines of the field of geology. In the field of paleontology, its effort is greater than that of any other university in the system (Table 2.1 and 2.2). Toronto is notably strong in the traditional fields of geology and in experimental petrology. The equipment available to the department is generally outstanding. We note that in the CUDG(O) Report, this university claims not to concentrate on environmental, marine, or limnological studies, but we believe that their efforts in these fields are quite adequate. This university claims strength in the field of engineering geology, a claim which we believe is justified. Of the four older universities, the University of Toronto seems to us to be rather on the defensive, an attitude which we did not understand. We have commented before on the dismal housing of the geology and geography departments.

The University of Toronto enjoys the heaviest concentration in the system of geophysics and geochemistry. The geophysics laboratory (in the Department of Physics) enjoys strong traditions in the fields of applied geophysics, and in studies of global tectonics. This group benefits from the support of a strong physics department. The preparation of Toronto's undergraduate geophysics students is recognized to be outstanding. We

sense an apparent lack of leadership in the geophysics group; admittedly, it seems to function quite well without it.

We noted isotopic and paleomagnetic studies of lunar materials, rare in Canadian universities.

The geomorphologists in the geography department are especially strong in field operations in fluvial morphology, and enjoy a sound reputation for the quality of their preparation of students.

University of Western Ontario:

12.5% research and graduate instruction
20.5% of Ph.D. students
11.5% of M.Sc. students

In the Department of Geology at this university, we observed an outstanding research group in geomorphology and good research in paleontology. Here, especially, graduate students were noticeably interested in and excited by economic geology; this is probably a healthy view at the present time. We were told that the university is planning for a necessary strengthening of analytical facilities, and we concur that this is needed.

This university is one of the two provincial centers for geophysics in Ontario. It achieves an excellent balance between pure and applied emphasis.

We observed at this university the only facility capable of studying minerals at very high pressures. The documentation provided to us through ACAP showed a very high manpower devoted to geochemistry, although the CUDG(O) Report claimed no concentration or emphasis in this field. The latter view seems more consistent with our observations, and perhaps some imbalance might be inferred.

In terms of geography, pedology has been singled out as the only active sub-discipline. We can find no fault with this choice.

Carleton and Ottawa

These are also mature universities at which we noted respected researchers in many of the SES sub-disciplines. Close proximity to and strong interaction with federal laboratories is one of their principal characteristics. Their sizes, relatively small in comparison with the first group, are at least partially compensated by good cooperation between sub-disciplines; e.g., between geomorphology and civil engineering. Although Pre-Cambrian was not

chosen to be one of the SES sub-disciplines (we think properly so), the choice by these universities to direct a substantial part of the research effort to Pre-Cambrian applications seems entirely appropriate.

Carleton University:

10% of research and graduate instruction
5% of Ph.D. students
9% of M.Sc. students

In the geology department we see distinct strengths in such fields as engineering geology, geochemistry, structural geology, economic geology, and petrology. There are quite good facilities for experimental geochemistry, as well as mass spectrometry facilities for both stable and radiogenic isotope measurements. We would question the choice of the geophysical emphasis which seems to invite little interaction with other geologists. Activities in physical geography are expanding. They are specialized and very well equipped for their specialties. The application seemed to us to be quite well chosen. Activities in geography-based geomorphology are expanding from a base of applied permafrost research. These activities are greatly assisted by a workshop where instruments can be not only produced but also designed.

University of Ottawa:

3.5% of research and graduate instruction
10.5% of Ph.D. students
4 % of M.Sc. students

Of these figures, we note that 3.5% of the provincial effort in research and graduate instruction does not seem to justify 10.5% of the Ph.D. enrollees. These and other figures seem to imply that the university is somewhat overextended in its Ph.D. programmes. For example, the data provided to us by the university showed 0.65 FTE faculty members supervising five Ph.D. students in structural geology. In spite of this criticism, we agree that there is considerable potential for research in structural geology and petrology at this university. We are aware of no geophysics, but there is notable activity in sedimentology and geochemistry. In the geography department we see a concentration on sub-disciplines which is unusual in the system. In the geography department there is an unusual, but highly commendable, integration with civil engineering, which produces work in applied geomorphology as this is understood in France.

The recommendation to combine the graduate program at Ottawa and Carleton if implemented would produce a strong well balanced unit.

Brock, Lakehead, Laurentian, Waterloo and Windsor

These universities are noticeably younger, and the solid earth science disciplines less developed, than in the case of

the other universities mentioned above. The Ontario university system would certainly not suffer if these universities were not to offer Ph.D.'s during the planning period. A single exception to this remark is the very narrow subdiscipline of groundwater geology for which a Ph.D. programme should be considered at the University of Waterloo. This would require appraisal by acknowledged experts in this particular sub-discipline, including experts who could determine the social need and advise on the details of any recommended programme.

The offering of M.Sc. programmes by these universities is bound up in rather complex provincial planning policies. The two principal statements relevant to this decision seem to be the following:

> ". . . accept the principle that the emergent universities should offer some M.A. and M.Sc. work in the central disciplines, simply because they are universities, and without justification on the basis of an overall provincial plan for graduate work in each subject separately. Hence the embargo on these universities' new programmes was to be removed through a different process, namely the approval of a five-year plan presented by each university showing the sequence of initiation of new fields."
>
> (COU: "Activities in Graduate Studies" 1971-72, Sept. 14, 1972)
>
> "This means that the committee concurs with the view that each of the emerging universities should be allowed to proceed with new programs development, but that this development be restricted to masters' programs at this time, and that it be *selective in its emphasis.*"
>
> (CUA: "Procedures for initiation of new graduate programs" June 8, 1972)

In our view it would be irresponsible to interpret these statements as justifying the indiscriminate development of M.Sc. activities. We interpret them to be very restrictive in the sense of selection of subdisciplines and in the implication that not all of these universities will choose to develop solid earth sciences in their overall plan.

Brock University:

2% of research and graduate instruction
0% of Ph.D. students
0% of M.Sc. students

The geology department at Brock University has deliberately chosen to conduct integrated earth sciences and allied studies relative to the Quaternary. They expect to have special emphasis on palynology and radio carbon dating. Its laboratories are well designed and equipped both for teaching and research. The department has made successful efforts to foster an interest in the solid earth sciences within the high school system. We consider that it is now ready to define the subdiscipline for specialization and open an M.Sc. programme.

Lakehead University:

1.9% of research and graduate instruction
0% of Ph.D. students
0% of M.Sc. students

The SES departments at Lakehead University provide an opportunity for undergraduate education in this discipline to students in this relatively remote area of Ontario. The research activities of the staff in the Geology Department quite properly relate to Pre-Cambrian problems, economic geology, and the sedimentology of the Lake Superior basin. Participation in the Geotraverse project is a natural development and should be encouraged as a natural focus for staff research. If there is an institutional decision not to develop a Master's programme, every effort should be made to optimize the research potential of the faculty in SES at Lakehead as this location offers geographical advantages for liaison with other institutions.

In physical geography the stated intent to concentrate on studies of landforms, land utilization, and the recreational potential of the North Shore of Lake Superior is commendable.

The coordinated science equipment and workshop area indicate wise planning and a high level of collaboration among science departments at Lakehead. It is hoped that the continuance of this collaboration will lead to interdisciplinary research projects that relate to the Lakehead area and the more remote areas to the north.

Laurentian University:

3.27% of research and graduate instruction
0 % of Ph.D. students
2 % of M.Sc. students

The location of this university and the need for applied economic and mine geologists indicate a strong development in this aspect of the solid earth sciences. Graduate work at the M.Sc. level should restrict itself to this range of activity and should relate all subdisciplines to this objective.

We would like to see some strengthening of the competence in exploration geophysics and in basaltic magmatism. We believe that this university is not taking sufficient advantage of the total Sudbury setting. The university should be able to benefit greatly from distinguished visiting experts, interested in the unique geology of this area.

University of Waterloo:

7.5% of research and graduate instruction
.6% of Ph.D. students
7.8% of M.Sc. students

Half of the stated research efforts in environmental geology in the system is taking place at Waterloo (Table 2.2). The principal area of excellence is in groundwater geology and associated studies. This latter strength should be recognized by a funded Ph.D. programme specifically related to groundwater geology. Other subdisciplines in the department should continue to recognize this area of strength and orient, as far as possible, their activities in support of it. The division of environmental studies in the University should likewise welcome and support this area of strength.

The department as a whole is developing good balance at the undergraduate and Master's level. The concept of having students move in and out of the programme and thereby gain practical experience is one that should be evaluated by other institutions. If this results in a better education for SES students, others should consider similar developments.

The groundwater group at Waterloo and the land resources science group at Guelph are cooperating in graduate course offerings in a way that will lead to the enrichment of both programmes, and this collaborative activity should be recognized and encouraged by both institutions.

University of Windsor:

3.5% of research and graduate instruction
0% of Ph.D. students
2 % of M.Sc. students

The geology department of the University of Windsor has informed us that they intend to direct their graduate programmes towards petroleum geology and industrial minerals. We believe that petroleum geology is much too broad a term to indicate a particular specialty. It is questionable whether any university in Canada pretends to cover all of this field. We believe that the choice should be more narrow, and that emphasis should be on problems which deal with the Niagara Peninsula setting. The choice of specialization on industrial minerals seems appropriate, with the

implication that it would involve also the engineering geology of solid rocks. This university has a conspicuously large undergraduate base.

We noted particularly how well this department integrated its geophysicist and geochemist into their earth science research. We would like to see more of this elsewhere. Although few departments should offer geophysics degrees, all should have enough competence in geophysics and geochemistry to support its principal research activity. Research in paleomagnetism seems appropriate and well-directed.

We understand that the geography department at the University of Windsor has not been appraised and believe it should be appraised with the aim of helping it to be more effective. We believe that its research objectives were somewhat limited, and that the statements of support and productivity were demonstrably inflated.

The University of Guelph

15.1% of research and graduate instruction
5.3% of Ph.D. students
10.6% of M.Sc. students

The outstanding research effort in the subdiscipline of Pedology is recognized by the 13% of a total of 14% in the total system is centred at Guelph. In other words, 93% of the Pedology in the province is carried out at this one institution.

The SES programme at Guelph has done an outstanding job of bringing various disciplines to bear on the studies of soil systems. The decision not to develop a conventional geology department but rather one that supports soil sciences is a good one.

The collaboration with the Ontario Soil Survey unit which is funded by the Ontario Ministry of Agriculture and Food, the Department of Agriculture, and the University of Guelph provides a model that should be studied by other SES units who will undoubtedly seek similar structural arrangements in order to further and maximize research effort with public funds.

With the close collaboration that exists between soil science, plant science and animal science, the unit at Guelph is well equipped to continue to develop along areas of current strengths with an increased activity indicated in applications of remote sensing to land use problems and detailed studies of soil systems as they relate to waste disposal.

SECTION 5: RECOMMENDATIONS

5a. Enrolment Projections

In order to define a minimum situation, we have assumed initially that educational demand will keep pace with the projected population growth of Ontario, but the increasing sophistication of the economy, increased interest in education for cultural purposes, and reduction in the import of earth science workers because of recent immigration policies will have no effect. (According to Science Report 13, Blais, about two-thirds of the earth science labour force is currently imported.)

To arrive at the base figures, we have used the DTE projections cited in the Wright Report (Table D-4). These projections deal with the 18-24 year age group: they incorporate allowances for immigration, mortality, and change in the fertility rate. Projections for the next ten years should be reasonably firm, since for the most part they represent head counts of human beings alive now, and in the Ontario school system.

We cannot persuade ourselves that, over the 10-year term, increase in SES student enrolment should fail to equal the increase in the 18-24-year-old population. Fig. 5.1 illustrates some projected growth trends for Ontario. In the face of a rising population and an even more rapidly rising gross provincial product, a stationary enrolment in SES seems to us both undesirable and unlikely. Indeed, we might well remark that a no-growth situation would not be in the national interest, and that undue reliance on the import of foreigners (whether permanently or temporarily) and on foreign expertise is bad in principle. We recognize that the economics of the mineral exploration industry fluctuate rapidly, and that the job prospects of SES graduates are closely coupled to the fortunes of that industry, so that short-term variations in demand for SES graduates, and variations of considerable amplitude, are to be expected and will need to be lived with. But, simply because a mineral resource is by definition a wasting resource, we can foresee no long-term decline in mineral exploration.

Our minimum assumption is, then, that Ontario can maintain its present proportion (13%) of the 18-24-year age group in universities: and that the province can continue to afford the existing ratio of graduates to undergraduates -- that is to say, that the total of graduates in the Ontario university system will continue to equal 12% of the total of undergraduates. Put in another way, the assumption is that a number equivalent to 1.56% of the 18-24-year age group will be enrolled in graduate school. The present fraction of all graduate students who are students of the solid earth sciences is 2.8%. We can conceive of no likelihood that the graduate population in SES in Ontario, averaged over the 10-year period, will be less than that obtained by projecting with these ratios.

The assumptions made so far, of nil increase in university participation, and of nil differential growth by SES, predict an increase in SES graduate enrolment from 400 in 1971/72 to 518 in

Figure 5.1 Some Growth Trends for Ontario
Sources: as indicated

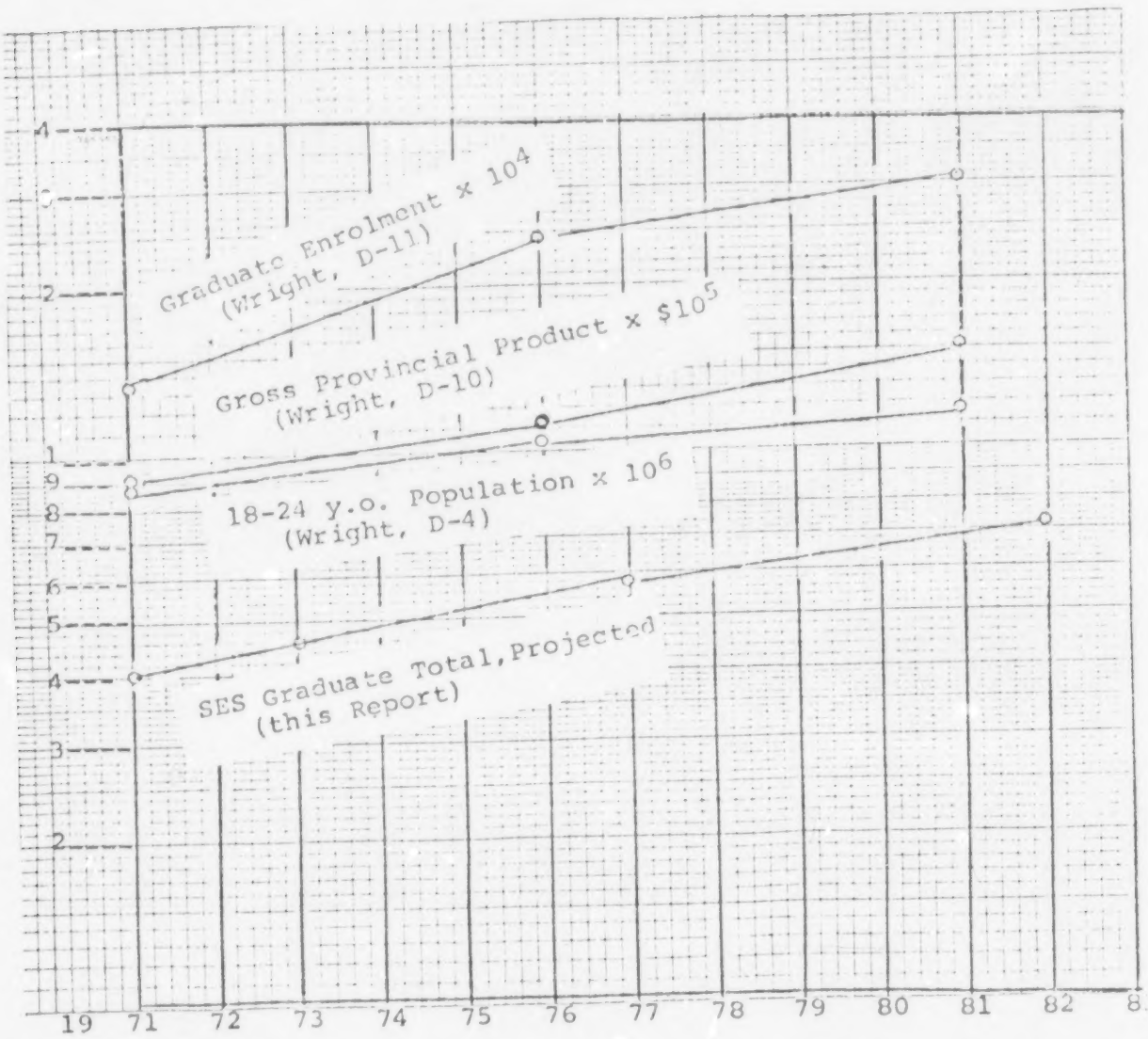


Table 5.1 PROJECTIONS OF ONTARIO STUDENT POPULATION, AND MODEL FOR SES GRADUATE POPULATION, 1973/74 to 1982/83

	Year	18-24 Total[1]	No. in Univ.[2]	Grad. Students[3]	SES Grad Students[4]	SES Proposed[5]	Wright[6]
	71/72	898,000	117,000	14,000	400	400	413
	72/73	(927,000)*	121,000	14,500	406	430	
First 5-year	73/74	(958,000)*	125,000	15,000	420	462	
	74/75	(989,000)*	129,000	15,500	434	495	
	75/76	(1,022,000)*	133,000	16,000	448	529	
	76/77	1,060,000	138,000	16,600	464	562	690
	77/78	(1,084,000)**	141,000	16,900	473	593	
Second 5-year	78/79	(1,109,000)**	144,000	17,300	484	622	
	79/80	(1,134,000)**	147,000	17,600	484	649	
	80/81	(1,160,000)**	151,000	18,100	506	675	
	81/82	1,188,000	154,000	18,500	518	700	868
	82/83	1,188,000	154,000	18,500	518	725	

* Interpolated at 3.3% p.a.
** Interpolated at 2.3% p.a.

1 Demographic (Wright)
2 13% of 18-24 age group (historical)
3 12% of undergraduates (historical): no increased participation.
4 2.8% of graduates (historical): no increased participation rate of number in university increases to 16.3% of the age group by 1977/78 and to 18.2% by 1982/83, OR SES becomes 3.5% of graduate student population by 1977/78 and 3.9% by 1982/83.
Example of combination effect: 14.65 university participation, and SES becomes 3.15% of graduate student population, by 1977/78.
6 Wright, D-11, assuming 2.8% of graduates in SES.

1982/83 (Table 5.1). These totals provide us with lower limits.

In order to define upper limits, we have considered the minimum totals of graduate population to be increased by the additional factors discussed in the Wright Report. In that Report, predictions are based on assumptions additional to, or different from, those already made: namely, that the proportion of the 18-24 year group that attends university will increase substantially beyond 13%, and that the ratio of graduate to undergraduate population will also increase slightly. We consider this set of predictions to be quite optimistic, on the grounds that, in our opinion, it probably overestimates the increase in university participation, and that it would involve costs likely to be quite unacceptable to the Ontario taxpayer. SES graduate populations predicted on the assumptions used in the Wright Report are 690 for 1976/77 (against a minimum figure of 464) and 868 for 1981/82 (against a minimum figure of 518 (Table 5.1).

We are founding our own projections and our consequent recommendations on an intermediate situation: rather, on two variants of an intermediate situation. In defining this situation, we have had regard to recent trends in the growth of SES relative to other graduate operations. We are assuming either that university participation will rise to 16.3% of the 18-24-year group by 1977/78, and to 18.2% by 1982/83, or that SES graduate enrolment will become 3.5% of the graduate total by 1977/78 and 3.9% by 1982/83; alternatively, that some combination effect of less marked increase, both in university participation and of relative interest in SES, will lead to identical results. Such a combination could be, for instance, an increase in university participation from 13% now to 14.65% in 1977/78, and an increase in the SES graduate population from 2.8% of the total graduate population to 3.15% in 1977/78 (Table 5.1).

On this basis, we are projecting an increase in the SES graduate population from 400 (actually rather more: see above) in 1971/72 to 593 in 1977/78 and 725 in 1982/83, representing an increase of about 38% over the 1972/73 totals by the end of the first planning period, and about 68% by the end of the second planning period (Table 5.1: SES Proposed).

Table 5.2 repeats our projections from Table 5.1, but breaks them down into master's and doctor's candidates. It also separates off part-time totals for master's candidates, using the currently observed ratio of fulltime to part-time master's. In addition, the currently observed ratio of doctor's to master's is built into the projections. Table 5.2 also lists new places needed, and predicts annual outputs.

We recognize that recent data indicate a national decrease in graduate enrolments, although M.Sc. enrolments have continued to increase in Ontario, and geology graduate enrolments for Canada as a whole were higher in 1972 than in 1970, both at the M.Sc. and at

Table 5.2

PROJECTION OF GRADUATE ENROLMENT AND OUTPUT

			First 5-year planning period					Second 5-year planning period				
	71/2	72/3	73/4	74/5	75/6	76/7	77/8	78/9	79/80	80/1	81/2	82/3
System total	400	430	462	495	529	562	593	622	649	675	700	725
Masters', all	220	258	277	297	318	339	358	376	393	408	422	435
(""", PT)	(44)	(47)	(50)	(52)	(55)	(60)	(63)	(65)	(70)	(72)	(75)	(75)
Doctors'	171	172(2)	185	198	211	223	235	246	256	267	278	290
New places needed, start of year, total		30	32	33	34	33	31	29	27	26	25	25
for Masters'		18	19	20	21	21	19	18	17	15	14	13
for Doctors'		12*	13	13	13	12	12	11	10	11	11	12
Maximum expected output at end year Masters	44[1]	50	55	60	65	70	75	80	85	90	95	100
Doctors	33[1]	35	37	40	43	46	49	53	55	58	61	64
Maximum expected output in 5-year period Masters							325					450
Doctors							215					291

-[1] actual 71/2 totals [2] 1972-73 Doctors' enrolment is expected to be similar to 1971-72 figure.

- 1972/73 totals are interpolated.
- The proportion of PT Masters' represents the existing 15-20% proportion. Projected maximum output of PhDs assumes 4-year terms. Projected output of Masters assumes that existing proportion to previous enrolments, and effect of PT work and upgrading, will continue.

the Ph.D. level (Table 5.3). Changes in trends of graduate enrolment are most marked at the Ph.D. level. Among the reasons for a decrease here in 1971 seem to be cautious university decisions on admission, changing attitudes of prospective students, and heavy-handed changes in government policies. Our view is that the reluctance of some potential students to consider graduate programmes stems largely from widely-circulated misinformation about employment prospects, and is not in the national interest. The additional recognition of the cultural and intellectual value of postgraduate education has been eroded at the same time. The growth model we propose can, in our opinion, be defended as desirable and realistic.

We have been interested to observe that an educational plan for Britain looks to a 22% rate of university participation for the 18-year-old population by 1981, a graduate student population equal to 17% of the undergraduate population in 1976/77, and a 15% increase in graduate student population between 1971/72 and 1976/77 (Table 5.4). Our expectations for SES in Ontario are more modest than this. They are also, as indicated, more modest than predictions from the participation rates recommended in the Wright Report. At the same time, we agree with the principle of that Report, that the Ontario university system should attempt to relate the educational opportunity of the Province's citizens to growth in gross provincial productivity.

If the major SES departments are able to take proportionate shares of the predicted increases in SES graduate enrolments, we foresee little difficulty in accommodating the increase in the first five-year period, and the proposed distribution for 1977/78 is shown in Table 5.5. This table indicates the most probable enrolments as well as those that are the minimum acceptable, in order to bracket the possibilities for planning purposes. However, some major departments have indicated an intention to undergo little or no growth, whether because of lack of space and funding, internal policy decisions, or constraints of university planning. Toronto, Western, and McMaster in particular may be unprepared or unable to accept the implications of the continuing development of SES in Ontario. Some comments from these institutions refer to rigid governmental attitudes that prevent anything but a very slow expansion at established centers.

If the major institutions will not, or cannot, take their proportionate share, and if graduate SES enrolments increase in anything like the manner that we are predicting, then the developing centers will be chiefly responsible for accommodating the additional graduate students and the distribution shown in Table 5.5 will have to be modified considerably. The CUDG(O) view is that the developing universities are likely to expand faster than established and older universities, and that in consequence they are likely to take an increasing proportion of the SES enrolment. But if new graduate programs are to be developed where they do not now exist, careful attention will need to be given to the provision of adequate facilities and of sufficient, and competent, faculty.

We have considered the demand for SES graduates in recent

Table 5.3 GEOSCIENCE ENROLMENT, CANADA.
Source: Geotimes, Dec. 1972, p. 23.

Year	M.Sc.		Ph.D.	
	Number	% change from 1970	Number	% change from 1970
1970	298	...	193	...
1971	272	--9.0	195	--4.2
1972	380	+27.5	261	+35.2

Table 5.4 DATA FROM THE TEN-YEAR PLAN FOR BRITISH EDUCATION
Source: A.C.U. Bull. of Current Documentation, No. 7, Feb. 1973.

A. % and predicted % of Age 18 in Higher Education: 1961, 7%; 1971, 15%; 1981, 22%.

B. Predicted increase in university enrolment: From 236,000 in 1971 to 375,000 in 1981--about 60% increase.

C. Student populations:

Year	U/G		Graduate	
	Numbers	%	Number	Increase
1971/72	236,000	19	44,840	
1976/77	305,882	17	52,000	15.9%

D. The British Model:

Year	% of 18-yr group	% Grad. of total	Total Effect
1971/72	15.0	19	2.85
1976/77	18.5	17	3.14
Increase	3.5%		0.29

Table 5.5

PROPOSED DISTRIBUTION OF GRADUATE STUDENTS 1977/78[1]

University	Masters Students		Ph.D. Students		Total
Brock	4	(3)	0	(0)	4 (3)
Carleton	40	(34)	15	(13)	55 (47)
Guelph	39	(34)	11	(9)	50 (43)
Lakehead	0	(0)	0	(0)	0 (0)
Laurentian	5	(4)	0	(0)	5 (4)
McMaster	56	(48)	44	(38)	100 (86)
Ottawa	11	(9)	20	(17)	31 (26)
Queen's	63	(54)	49	(42)	112 (96)
Toronto	68	(58)	48	(41)	116 (99)
Waterloo	24	(21)	2	(2)	26 (23)
Western	44	(38)	46	(40)	90 (78)
Windsor	4	(3)	0	(0)	4 (3)
TOTAL	358	(306)	235	(202)	593 (508)

[1] First column in each case are figures recommended, those in brackets represent minimum enrolments.

years, and have used the results of our analysis to test the rationality of our projections of future output. The production and disposal (we are aware of the possibly unfortunate connotations of these terms) of Ph.D.'s and ABD's by the Ontario SES system for 1967-72 are listed in Table 5.6. In the right-hand columns, this Table also lists demand projections for 1973-78, based on the DaSilva model and on a 50% rate of the DaSilva model. The DaSilva model depends on the analysis of the ACAP Research Unit, which arrives at a demand for 19 SES university faculty per year up to 1977/78. As we have shown earlier, age retirements by themselves indicate a lower demand rate; but some increase should be built in, to accommodate movement out of the Ontario system. A simple but surely conservative projection is that Ph.D. demand will run at 50% of the rate predicted by the DaSilva model. Calculating from existing distribution of Ph.D. employment, and from 50% of the DaSilva projection of demand of faculty employment, we arrive at the demand totals listed in the extreme right-hand column of Fig. 5.6. Our projected demand for between 373 and 185 is closely similar to the projected output of 215 (Table 5.2).

We have encountered the opinion that actual Ph.D. employment may not be identical with desired employment: that is, that SES Ph.D.'s may find themselves obliged to take employment outside areas that they originally envisaged. If this means the dissemination of professional expertise through the social community, we can find no objection to it. Furthermore, we consider that a switch of direction from narrowly-based and strictly academic research could often be beneficial, both to new Ph.D.'s and to their employers.

Our recommendations on future SES graduate enrolments now follow.

RECOMMENDATIONS 1: PROJECTED GRADUATE ENROLMENTS IN SES

1.1 Enrolment projections should be based on the demographic projections made by DTE and cited in the Wright Report.

1.2 Projections of graduate enrolments in SES should be based on an approximate mean between a nil increase in university participation by the relevant age group and the rate of increase forecast in the Wright Report. That is, the projections should be based on an increase of about 7% per annum during the first five years, and 4% per annum during the second five years.

1.3 Future graduate enrolments in SES should be estimated to continue at about 60% Master's, 40% Doctor's.

Table 5.6 DEMAND MODEL FOR Ph.D. and ABD FROM SES SYSTEM IN ONTARIO

Employer	Total for 1967/72	Percent	Demand (5 years to 1978)	
			DaSilva* Model 73/78	50% of DaSilva Model 73/78
University	35	25.4	95	47
Industry	42	30.4	114	57
Government	30	21.8	81	40
Colleges, High Schools	0	0.0	0	0
Fellowships	20	14.5	54	27
Research and Other	3	2.1	8	4
Unknown	6	4.4	16	8
Unemployed	2	1.4	5	2
TOTALS	138	100.0	373	185

* Using DaSilva (ACAP Research Unit) model of 19 SES staff needed for universities each year, and applying this plus the observed demand profile to the first 5-year planning period.

1.4 On the basis of 1.1, 1.2, and 1.3, the following projections should be adopted for planning purpurposes. The larger figures we consider to be the most probable, those in brackets represent minimal acceptable enrolments.

	1973/74	*1977/78*	*1982/83*
Total SES Graduate Enrolment	*462 (400)*	*593 (510)*	*725 (620)*
of whom Master's	*277 (240)*	*358 (306)*	*435 (370)*
of whom Doctor's	*185 (160)*	*235 (204)*	*290 (250)*

1.5 Although we regard our projections as conservative, involving (so far as we can determine) no risk of a Ph.D. surplus in SES, the current situation should be kept under constant review.

1.6 If our projections prove to be seriously in error, to the extent that the SES graduate population in Ontario increases very slowly or not at all, then the whole situation should be reevaluated. Although we view with great distaste any selective penalization of SES units, a serious contraction of graduate enrolments could make it appropriate to consider a reduction in the number of such units.

5b. Graduate Admissions and Conditions of Graduate Candidacy

We fully endorse the opinion, expressed to us by many groups of graduate students, that much recent official ruling particularly concerning the structure of graduate support and graduate study fees, has been heavy-handed, and has failed to demonstrate understanding of the graduate student role in the university system. University systems are delicate. A sudden input of official regulation, particularly if it represents a sudden shift of policy, can have disastrous results. We detected wide variation among SES units in responding to the requirement that graduate studies should be accountably conducted on-campus only. At least one SES unit has felt obliged to limit the chances of its graduates to interrupt their studies in order for them to work for government or industry. Such a procedure is unwise, in our view, for any discipline. It is particularly unwise for SES, where many students need to be off-campus during the summer field season, in order to carry out their field research. The insistence on on-campus presence reflects an attitude that graduate work only within the university should be considered valid for grant purposes. We consider this insistence to be misdirected as graduate students in SES can carry out bona fide research on and off the campus.

We fully endorse the students' view that, if enrolment must be limited, the limitation should be based on academic criteria and not on the financial squeezing of graduate students. A direct

quota seems to us an honest approach, even if difficult to administer.

We observe that about 1/3 of the masters' candidates and about 2/3 of the doctors' candidates are non-Canadian and/or the holders of non-Canadian first degrees, but we also recognize that many Canadians undertake graduate study abroad. We consider that, as a matter of principle, graduate students in any discipline should be encouraged to seek wide intellectual and social experience. We find it very difficult to infer that the non-Canadian/Canadian ratio of graduate students in SES in Ontario is unduly high. We know that the breakdown of SES graduate population by citizenship (Table 2.4) can be read as indicating a considerable inflow from outside, but we are also aware of studies that clearly demonstrate a balance, and in some respects an overbalance, between 'foreign' students at Canadian universities and Canadian students abroad. Any supposed economy resulting from a restriction on non-Canadian graduate students in SES we regard as false. The intake of non-Canadian students involves a healthy interchange.

Obviously, it would be possible for irresponsible centers to accept large numbers of inadequately prepared foreign students, merely for the sake of boosting enrolments. We have observed, in sundry university systems, that a boosting policy merely leads to trouble. We are satisfied that the Ontario SES system is well able to police its own institutions, with a view to discouraging abuses of admission. We conclude that, provided the system continues to behave sensibly in this regard, government authorities should exercise extreme restraint in imposing constraints on the direction of graduate inflow. We are particularly impressed by the fact that, during recent years, the U.K. has become easily the principal supplier of non-Canadian Ph.D. aspirants, the data available to us give no indication whatever of a dilution of the Ontario SES graduate system by part-time non-western students (Table 2.4). We wish to stress that this comment is not intended in any racist sense. On the contrary, it is meant to show that the Ontario SES system is competing for graduate applicants in the toughest possible market.

Our recommendations on admissions policies now follow.

RECOMMENDATIONS 2: ADMISSION POLICIES

2.1 Admissions should be based solely on academic criteria. An admitted student should be assured of financial support at a minimum level of adequacy. No attempt should be made to use reduction of support or increase in fees as a means of curtailing enrolment.

2.2 Extreme caution should be exercised in raising financial barriers to the international exchange of graduate students.

5c. Development of Specialisms, and Expansion at Particular Centers

We have previously presented some views on the strengths and weaknesses of the Ontario SES system. We are glad to see that certain institutions, particularly some of the emerging institutions, are channelling their efforts into particular specialisms. We firmly believe in a critical size for the development of good schools, and believe also that that size is likely to be attained within well-bounded areas.

Our Recommendations 3, below, make specific mention of such fields as quaternary studies, pedology-geomorphology, geophysics, and marine studies. We do not intend that our recommendations should obstruct development of these or other subdisciplines at any center, but only that the subdisciplines indicated might be the especial responsibilities of selected universities. For example, it is our view that most geologists should be able to take more advantage of geophysical techniques. In consequence, we suppose that many SES institutions might employ one or more geophysicists able to contribute to active geological research, whereas the development of geophysics as a discipline in its own right should be limited to only two or three institutions. If a third major geophysics laboratory is contemplated, it should be initiated where it would help to consolidate general research into the solid earth sciences.

We feel most strongly about the need for further development of marine sciences and of scientific studies on Hudson's Bay. This would seem a particular responsibility of Ontario universities, and one that is of practical and fundamental importance.

Marine geology embodies aspects of several fields of earth science (sedimentology, stratigraphy, geochemistry, geophysics, paleoecology, etc.). The graduate studies in marine geology recommended should take place in institutions with strength in the above (Queen's, Toronto, McMaster, Western, Carlton/Ottawa). Appraisal of each will be necessary to determine this detail. The "pure" aspects of the subdiscipline will be less important as the applied will dominate in marine geology.

Many of the senior Ontario universities indicated that they planned no expansion of their earth science programmes. Only at Queen's did it seem that the decision was the result of careful and well considered long-range planning. We consider it probable that Toronto will need to take its share of our projected increase in enrolment. The difficulties of expansion on the St. George campus are quite evident, and we suggest therefore some acceleration of the earth science developments at the Erindale campus. We are encouraged in this suggestion by the freshness of the approach of the Erindale group, and by its truly interdisciplinary character.

Even when we take linguistic considerations into account, we fail to see that it is useful to fragment the SES activities at Ottawa by distributing SES activities between two universities that are close neighbours in a single city. Throughout our analysis

we have tended to regard the two as a single unit. As such, we see them as forming a single, and major, element in the SES system of the province. We understand that the whole future of the Ottawa unit has recently been assessed, and that a decision has been taken to support its existence and to promote its development. We also understand that earlier discussions of possible combined operations came to nothing on the university administrative level, but that prospects for combination are now brighter and are favoured by the two SES units. We consider that much could be gained by the merging of the two graduate operations, and that the combined potential would be nothing but beneficial to both units, as they now separately exist. Merging or combination of undergraduate major operations is largely a separate matter, which could well be deferred until a later time. Merging of operations at the graduate and research levels, in geography-based geomorphology, could readily be accommodated by classifying the geography-based geomorphological faculty, in both institutions, as common to Arts and Science. Plenty of precedents for such a move are on record elsewhere.

Geophysics at Toronto is a subdivision of the Department of Physics, with considerable autonomy. Interaction with geology, rather weak at present, promises to improve in the near future. In any case, previous arrangements have produced a very strong school of mining exploration geophysics. Western has the one independent Department of Geophysics in Canada that is limited solely to geophysics. It has not yet achieved the maturity of the University of Toronto department, but has achieved a significant reputation. Elsewhere, geophysicists, and some geochemists, seem rather isolated, except at Windsor where geophysical and geochemical research has been intelligently modified to match other SES work.

Taking account of the desirable input, as we judge it, of geophysics into geology, and of the desirability that a fifth or more of the SES graduate output should have competence in geophysics, we suggest that three, rather than the existing two geophysical groups would be appropriate. We also suggest that a third group could well be part of a Department of Geology.

RECOMMENDATIONS 3: FURTHERANCE AND EXTENSION OF SPECIALISMS

3.1 Continued and increased emphasis should be placed on applied specialisms. Quaternary studies at Brock, pedology-geomorphology at Guelph, and environmental groundwater engineering at Waterloo should continue to be developed.

3.2 The establishment of a third major geophysics group, additional to the groups at Toronto and Western Ontario, should be considered. Such a third group could appropriately be located in a major department already well qualified in economic and structural geology, such as the Geology Department at Queen's.

3.3 Particular consideration should be given to the development of graduate studies in marine geology, with especial reference to the Hudson's Bay area. This recommendation takes account of the length of Ontario's sea coast, and the growing scientific and economic importance of continental shelves. An assessment should be made of how to structure this development, within the total system.

3.4 The University of Toronto should consider accelerating the developments of SES facilities at the Erindale campus.

3.5 Every effort should be made to merge the SES graduate programmes at Carleton and Ottawa.

5d. Programme Restriction and Personal Accreditation

Provided that full use can be made of human and academic resources, we consider that the Ontario SES system has the capability of accommodating the growth we foresee in the first five years. Accreditation of new centers should be undertaken, in that period, only after very careful consideration. However, we recognized at non-accredited institutions persons of substantial reputation and ability. It would be wasteful if these persons were not used effectively. We consider that suitable ways and means can best be discovered by the universities themselves, perhaps through CUDG(O). Among the possibilities that might be considered are the accreditation of individuals on an individual basis and for prearranged thesis projects, or the association of individuals with accredited centers for the purpose of supervising particular students, or the provision of research support independent of registration of graduate students. Whatever solution results, we think it should result from considered discussions and should be sufficiently widely publicized as to leave no doubt about procedures.

We are not persuaded by the view, advanced to us during discussions with the Discipline Group, that an SES unit with a full-fledged undergraduate program should be entitled, more or less automatically, to aspire to and obtain a graduate programme encompassing at least operations at the master's level. This view appears to be based, in one respect, on the idea that all emergent or otherwise developing centers could look, as a matter of policy, to the initiation of graduate programmes. If so, we take the situation to have been changed by the changing economic and academic circumstances of the 1970's, notwithstanding our predictions of an increase in graduate enrolments in the Ontario SES system. In another respect, the claim for master' programmes is based on the opinion that the master's degree in SES is a useful, prestigious, and marketable professional qualification. This assessment we welcome. We have been told that some Ph.D.'s find it difficult to accommodate themselves to the cold real world, since they wish only to do more of what they have been doing so far: and this opinion came from

some Ph.D. aspirants, among others. Nevertheless, we consider, as we have indicated earlier, that graduate programmes at the Master's level should dispose of sufficient academic expertise. There seems to us to be room in the Ontario SES system for a compromise between the blanket approval of graduate programmes and their blanket denial, by means of the accreditation of individuals in lesser centers, who would transfer their accreditation should they move from one lesser center to another center. For programme development, we are therefore recommending as follows:

RECOMMENDATIONS 4: PROGRAMME DEVELOPMENT AND PERSONAL ACCREDITATION

4.1 Ph.D. programmes in SES should not be considered during the first five-year period for Brock, Lakehead, Laurentian, and Windsor. The status and potential of these centers should be reviewed at the end of that period, in order to determine if the institution of a Ph.D. programme at one or more of them would be in the provincial interest.

4.2 It should be accepted that the projected graduate enrolments for the first five-year period can be accommodated in the SES system without Masters' programmes at Lakehead, Laurentian, and Windsor. Existing or proposed SES graduate programmes at these centers should be reappraised. Reappraisals should have regard to choice of areas of specialization, in relation both to the SES system and to the location of a given unit.

4.3 Notwithstanding the restrictions on centers recommended in 4.1 and 4.2, a mechanism should be developed to accredit individuals, wherever located in the system, to direct graduate work in particular subdisciplines or subdisciplinary groups, either at the Master's level or at the Doctor's level, as appropriate. Financial inputs resulting from individually accredited supervision should benefit the institution to which the accredited supervisor is attached. Methods of individual accreditation could be worked out for instance by CUDGIO, and could take account of the formalized practises, e.g., of the Universities of Toronto and London (U.K.).

4.4 Because we see inherent dangers in relating all research to graduate degree programmes, we recommend that funding be made available by Ontario for research independent of these programmes.

5e. Leadership and Cooperation

We have already expressed our opinions on the responsibilities of the solid earth sciences in the fields of environmental studies and geotechnique. We reaffirm our view that the Ontario SES group should assume a position of leadership in these areas.

We recognize the basic compromise between autonomy of institutions and the economical use of shared resources. We recognize that something, perhaps much, has been done to attain that compromise. However, we consider that geologists could work more closely than they do now with engineers, pedologists, and physical geographers, and that cooperation with government and industrial laboratories could be much improved. All the consultants feel that it should be an entirely natural occurrence for graduate students to carry out major parts of their thesis researches in government laboratories, perhaps under the supervision of government scientists. Despite what already occurs, we still feel that opportunities are open only to selected students through personal associations of their supervisors, and we believe that conjoint arrangements are seldom considered natural, either by the universities or by the government laboratories. Of course, political difficulties (provincial, national, and university) exist, but every effort should be made to overcome these.

The question of the cooperation between universities on the one hand and government and industrial establishments on the other was explored at all the universities visited. We posed a question in the form: 'How would you react to the suggestion that scientists working in government and industrial laboratories might hold cross-appointments in the university, that they should supervise the work of graduate students, and that graduate students might spend part of their time, perhaps whole academic sessions, working in laboratories outside the university?' The responses were almost all strongly positive, from faculty, deans, and students alike, and in a few cases arrangements approaching this situation are already in operation -- even though we were told in certain cases that they might not be welcome to the non-university establishments concerned. We quoted the systems operating in France and the U.K. as examples of the way in which a cooperative system can work. For the Ontario SES system, improved cooperation would require changes of attitude, both outside and inside universities.

Universities in the Ontario SES system differ in the extent of inter-department cross-appointments and sharing of resources. In Toronto, several professors hold appointments in more than one department, and at McMaster it appears that cross-appointments are common and of long standing. In as interdisciplinary an undertaking as earth science, cooperation is obviously called for, and should be encouraged wherever possible. The same applies to joint between universities, the more so as some of the laboratory equipment required is very expensive. Cooperation is developing, even outside the province of Ontario (Waterloo quoted one Saskatchewan professor who is supervising a Waterloo student), but could be much further

encouraged.

A special case is that of Carleton and Ottawa, which we have already discussed. We take it to demonstrate what can be done by way of cooperation at the working level, even when administrative obstacles prevent formal conjoint operation at the research level.

As to the use of non-university laboratories, we were informed at one center that provincial regulations allow students to spend the whole year in government or other laboratories: if this is so, it does not appear to be fully understood elsewhere. The idea was in general favourably received, but doubt was expressed about its acceptance by outside laboratories and organizations. Opposition, generally moderate, came from those who felt that the academic atmosphere might be lacking in outside laboratories, or that the university would "lose control" of the graduates concerned. Neither outcome, in our view, would necessarily be a bad thing.

Inter-university collaboration does not mean that there should be no duplication of effort or interest. A certain amount of duplication is unavoidable and in fact desirable; the undergraduate base certainly requires it, and from the purely research point of view it can often lead to advances which would not be made without it -- no two minds are identical.

Ontario has a wealth of laboratory equipment in many of the solid earth sciences, and will require even more. Associated with many of these facilities are experts with international reputations who should be available for consultation to all researchers. The usual procedures for awarding grants, and the customary attitudes of university scientists, have often encouraged an attitude of possessiveness on the part of owners of major facilities. This attitude may become too expensive for Ontario (or Canada) to afford, when education costs have risen to such substantial proportions. In Canada, the Ontario SES system is in a unique position to organize its major laboratory facilities and expert personnel in an exemplary fashion. In mary cases, adequate technical staff do not exist, and this difficulty would have to be met squarely. However, we believe that the scientific rewards could be well worth the effort taken to find appropriate means to the end of providing support staff.

RECOMMENDATIONS 5: LEADERSHIP AND COOPERATION

5.1 SES units should accept its important role in environmental studies, taking the fullest possible advantage of the interdisciplinary nature of the solid earth sciences, and of the broad competence of the geoscience professions in the study of the earth.

5.2 Means of improving cooperative endeavour should be earnestly pursued.

5.3 *Some appropriate agency should be charged with attempting to remove, or at least to lower, structural and procedural obstacles to close and formalized cooperation between university units on the one hand, and governmental and industrial units on the other.*

5.4 *Solid earth scientists, as a group, should take a more direct interest than hitherto, in such applied fields as geotechnique, engineering geology, and resource-related studies, in order that SES graduate students may cultivate a strengthened interest in applied aspects, in addition to pure aspects, of their disciplines.*

5.5 *Attempts should be made to remedy the diseconomy of distribution and use of major equipment and associated expert personnel which now exists in certain respects, by one or more of the following means:*

(a) Operation of major fixed equipment on a three-shift, or at least a two-shift, basis;

(b) Transfer of some items from departmental to group or university control;

(c) Guarantee of access (e.g., for night shifts) to needful workers from nearby centers and to periodic visitors;

(d) Continuing provision of sufficient academic and support staff;

(e) Inventory, with a view to redistribution, of idle or otherwise surplus equipment.

5f. Self-appraisal

The graduate students at several universities gave as their reason for going into graduate study "intellectual curiosity", or "general interest", thus over-reaching many of their professors, who took the more pragmatic (and orthodox) view that graduate training in the earth sciences was primarily for professional advancement. This has been referred to already in Section 2, but we think it can bear repeating more than once if necessary. The study of the physical home of mankind is of interest to all men, and those who go deeply into it should be commended for their enterprise. Furthermore, in these days of highly commercial interpretations of science policy by senators and by Treasury Board, it is healthy to remind the public and the administrators, both government and university, that the purpose of science is the investigation of nature, not primarily the exploitation of natural resources. In other words, we would emphasize

the difference between 'science' and 'technology', at a time when the two terms are being used almost as one. "Geology", said one professor (Toronto), "is low in status level"' and another: "Motivation in the high schools is low; it takes the university career to awaken interest in geology", and in "the intellectual values and problems of geology".

We met, at some universities, the feeling that graduate students were being inappropriately used as research assistants, and that double-author publication is not always justified. We think that some graduate students may fail to recognize that a principal investigator's name may need to appear on the statement of results obtained by means of funding secured by that investigator; and we are confident that practice in the solid earth sciences is less open to criticism than that in some other disciplines. At the same time, the research role of a graduate student deserves proper recognition. We recommend this whole matter to the attention of individual universities, departments, and professors. In the minds of the consultants, a related question is whether research in universities is necessarily bound up with graduate studies and graduate students. Ideally (as in the past), research can be done by individual professors in purely undergraduate universities and colleges; perhaps it is the cost of research equipment, and of field work, that has centered research in mature universities with well-developed graduate schools. Perhaps this is unavoidable, but it may be something to regret.

Because we were thoroughly impressed by the effective and realistic self-appraisal of the CUDG(O) group, our final recommendation is one of encouragement of its activities. The suggestion of more frequent, smaller, meeting on particular SES problems seems worthwhile; some smaller meetings might involve subdiscipline groups, or combinations of these.

RECOMMENDATIONS 6: SELF-APPRAISAL

6.1 CUDG(O) should be encouraged to collate and distribute data on the geological-geophysical units in the SES system. If possible, perhaps by cooperative endeavour, its tabular summaries at least should include also data on pedology and geomorphology. In addition, CUDG(O) should be encouraged to produce sequels or supplements to its report.

6.2 Members and units of the SES system should consciously assess the objectives that might be thought desirable for the system. Among possible objectives considered could be:

(a) To supply world leadership in some aspects, and by some centers;

(b) To supply leadership for Canada;

(c) *To supply Ontario, Canada, [illegible] wider market with trained professionals and/or intellectual pioneers;*

(d) *To sponsor system-wide specialty meetings or seminars for SES faculty and graduate students.*

6.3 *Members and units of the SES system in Ontario should think earnestly about what prospective interdisciplinary and intradisciplinary combinations there could be, in addition to those already existing and foreshadowed; and about possible major shifts in research design and direction.*

A P P E N D I X B

DISCIPLINE GROUP RESPONSES

Geography Discipline Group Response B-1 to B-3
Geology Discipline Group Response B-4 to B-13

McMASTER UNIVERSITY

HAMILTON, ONTARIO, CANADA L8S 4K1

DEPARTMENT OF GEOGRAPHY

December 12th, 1973.

Professor M.A. Preston,
Advisory Committee on Academic Planning,
Council of Ontario Universities,
102 Bloor Street West,
Toronto M5S 1M8, Ontario.

Dear Dr. Preston:

The Geography Discipline Group has, by telephone and letters, considered the resubmitted Final Report of the Solid Earth Sciences Assessment Committee. In the resubmitted version the recommendations remain essentially as they were in the earlier draft of the Report but it now provides some justification for projected graduate enrolments to 1978 and beyond; the various institutions are grouped by the size and length of experience of their S.E.S. units and they are given some individual assessment. In general, our opinions of this resubmission are more favourable than they were of the earlier version but none of us can be said to be very satisfied with it. Three of us express vehement dissatisfaction. We all feel that an opportunity for a clear appraisal with well structured recommendations has been missed. There is a consensus that geography-based geomorphology and pedology are under represented in the Report. There has been no attempt to evaluate strategies for integrating them. Many of us contend that specific attractive features within our individual departments have been overlooked: often this results from the fact that geomorphology and pedology were assessed separately from other important parts of physical geography, (biogeography, climatology, hydrology - considered in the Geography Report), so bisecting careful pedogogic structures.

Turning to points of detail, there are some errors of fact and of omission:-

Tables 2.1 and 2.2 show no research or graduate instruction in geomorphology at Ottawa, yet Tables 4.1 and 4.2 indicate that there were 5 Masters and 2 doctoral candidates being supervised there in 1971/72!

in Table 2.3 the system total of doctoral students in 1970/71 would appear to be 167, not 175 as cited. Similarly there should be 126 continuing doctoral students that year not 134.

in Table 4.1 the enrolment figures for Queen's University are in error.

on page A-37 there is a statement that at Ottawa there is "an unusual but highly commendable integration with civil engineering which produces work in applied geomorphology as this is understood in France." Surely this statement should have been applied to Carleton University, where it would be correct. The applied geomorphic work at Ottawa is highly innovative and owes nothing to expertise in France.

there is no assessment of geography-based geomorphology at the University of Guelph, although the department contains four specialists.

there is no assessment of geomorphology or pedology at Laurentian University, (two specialists).

at Brock University, geomorphology is taught in the geography department and is distinct from the Quatenary work of the geology department. This is not apparent in the report.

the assessment of the University of Windsor is outdated. The geomorphology component there was given but perfunctory treatment by one assessor. The M.A. programme was only three years old at the time of his visit and because two-thirds of the students were part-time, productivity to that date was necessarily limited.

On the recommendations of the re-submitted Report we would add these points to our comments contained in the Discipline Group's letter of April 13th:

Recommendations 1.1 - 1.6: Table 5.5 (page A-49) "Proposed distribution of graduate students 1977/78" is a useful addition in the resubmission but its implications are not sufficiently taken up in Recommendation 1.4. Many of us would prefer to see such proposed numbers cross-classified by sub-discipline and M.A. and Ph.D. categories, (geomorphology, minerology, etc) as was done in the Geography Report, for the various institutions.

We endorse the projected growth rates. Since 1971/72 there has been net growth of enrolment in geography-based geomorphology and pedology. Many of us have felt pressure to grow at or above the assessors' maximum projected rate, in so far as we have rejected numbers of well-qualified students because we had neither staff nor funds to support them.

Recommendation 3.1: "Continued and increased emphasis should be placed upon applied specialisms. Quaternary studies at Brock, pedology-geomorphology at Guelph ---- should be developed". Because geomorphology at Guelph is not assessed in any way, we do not understand what is intended by 'pedology-geomorphology'. We do not dispute the merits of applied work by Quaternary specialists at Brock but point out that Quaternary studies, per se, are no more applied than e.g. pre-Cambrian studies. This is not a clear recommendation.

Recommendation 3.3: We regret the especial emphasis that is placed upon the Ontario coast of Hudson's Bay. It is only a tiny part of Canada's vast northland. Conspicuously, the Report omits all reference to geomorphic and pedologic work that is being pursued actively in other parts of it.

Recommendation 3.5: Carleton University and the University of Ottawa reject any rapid merging of their S.E.S. units and the rest of us support them and understand their anxiety in this matter. The resubmitted Report contains no statement of what is meant by 'merge', no analysis of the structure, organization, nature, programmes, relationships etc. of the four departments that are to be partly or wholly merged.

Recommendation 5.5, 6.1 and 6.2: CUDG(O) is mentioned in these recommendations or is so situated that it can play a major role in carrying them out. At the time of the consultants' visits to S.E.S. units an 'Association of Ontario Geomorphologists' also existed in an informal fashion. Members had already exchanged equipment lists and expressed their willingness to share items. The Association now exists formally and has published a lengthy handbook which sets out in detail the undergraduate and graduate programmes, the laboratory and equipment facilities of individual departments. Under our supervision, we look to the Association to play the role in geography-based geomorphology that CUDG(O) is to play in geology, and also to collaborate with CUDG(O).

Yours sincerely,

Derek Ford.

Derek C. Ford,
Chairman of Geography, McMaster University,
on behalf of
the Geography Discipline Group.

DCF/k

GEOLOGY DISCIPLINE GROUP RESPONSE

A B S T R A C T

We welcome the general tone of optimism which characterizes the Report but we disagree with most of the specific recommendations because they are based on inadequate knowledge of the system. We recommend strongly against publication of the Report of the Solid Earth Sciences Consultants. We recommend that the Council of University Departments of Geology (Ontario) form a sub-committee to investigate the most suitable future development of Geophysics in the Universities of the Province of Ontario.

A superficial report is an abomination to the Lord; but a bullish future for those who must work on this Earth is His delight.

CUDG(O), 1,1.

1. The recommendations of the consultants and the analyses upon which they are based must be considered within the context of the broad scope of the solid earth sciences which draw upon the principles and concepts of physics, chemistry and biology for the solution of problems that range from the interface with astrophysics (lunar geology) through all the branches of chemistry (geochemistry) to ecology and invertebrate taxonomy (Paleontology). In addition to which the subject of geology has its own special philosophy which is nothing less than the comprehension of the succession of events and processes which have taken place in the five billion years of the earth's history.

The task placed before the consultants when perceived in the context and in terms of the past successes and failures of enrolment projections in post-secondary education is difficult if not impossible. In our opinion the task is certainly impossible when proper consideration is given to the complexity of the discipline and the richness and diversity of its expression in the Ontario universities. It is obvious to us that the Recommendations and any plans based on them must be subject to review on a short-term (annual) basis and cannot be accepted as rigid guidelines for a ten- or even a five-year interval.

2. We recommend strongly against publication of the Report because of its omissions, its inadequacies and its superficiality. The omissions which concern us are the lack of information about the present states of Departments, the lack of revised and accurate graduate enrolment figures, the lack of reference to research of particular

importance to one Department within the system and the lack of any analysis based on discussion with Government or other agencies. We understood, in the early discussions with the Executive Vice-Chairman of ACAP, that the Consultants would discuss the future role of the Earth Sciences in Ontario with the Geological Survey of Canada, the Ontario Department of Mines and with representatives of Industrial Corporations.

We deem the Report to be inadequate in that it is an elementary discussion of an exceedingly complex organism. The attempt to project graduate enrolment figures to 1977/78 is not successful as will be shown later. The Report suffers by comparison with the Special Study No. 13 'Earth Sciences Serving the Nation', Science Council of Canada, 1971.

The criticism of superficiality must be directed more to the Advisory Committee on Academic Planning than to the Consultants. Our opinion is that one Geologist and one Geophysicist cannot possibly comprehend the richness and diversity of the many sub-disciplines of the Earth Sciences found in the Ontario Universities. Of particular concern to us is that no detailed study of these sub-disciplines has been made.

Our overall impression of the Report is that it is a hurried examination of the immediate past situation in the Ontario Universities and that it is already out of date. We object to the cavalier way in which some aspects of our work are dismissed as being of no import-

ance and other aspects simply ignored. We are greatly concerned that non-specialists and, worse, non-scientists reading this Report would gain a most unfavourable image of our discipline. We emphasize that our criticisms are based on our collective regard for the discipline and that, in considering the Report, we have submerged any individual Departmental or University expression of opinion.

3. We are glad to see that the defamatory and temerarious statement that appeared on page 68, lines 11 and 12, of the 10th March, 1973, 'Report', has been deleted.

The establishment of a third major geophysics group (Recommendation 3.2, page A-55) is a highly debatable matter which would require most careful consideration. Such debate would have to take into consideration, for example, the demand for geophysicists (which may well be in balance with supply at present), the kind of geophysicist that is required (most graduates have not been trained in Applied Geophysics but there appears to be a growing demand on the part of students for this kind of training) and the level of training required by Industry (there is presently a belief that the requirement is mainly at the level of B.Sc. and M.Sc.). Further, although the Consultants make the case for a third geophysics group to be established in a fully developed Department of Geology, the case for expanding one or both of the existing Geophysics Departments needs to be examined, as does the case for the development of

either the Laurentian or Lakehead Departments.

We accept that the Consultants have drawn attention to a matter of primary importance for the future development of the Earth Sciences in Ontario and we therefore make this recommendation:-

That the Council of University Departments of Geology (Ontario) form a subcommittee to investigate the most suitable future development of Geophysics in the Universities of the Province of Ontario.

Moved by: Dr. W. Fyfe
Seconded by: Dr. D. Strangway.
Agreed.

What is also desirable, but is not made the subject of a recommendation, is the possibility that all Departments of Geology 'might employ one or more geophysicsts' so that 'most geologists should be able to take more advantage of geophysical techniques' (page A-54). We agree that much geological research can be strengthened by the contribution of geophysics but would add the need for enlarging the amount of instruction given in geophysics. There is an opinion that 'one or more' should read 'two or more'.

Recommendation 3.1, page A-55, is, of course, unexceptional as it stands. But it still makes no mention of the long established Quaternary Studies Group at the University of Western Ontario, to which we referred in our previous response.

The development of research and graduate studies is marine geology (3.3, page A-56) in the Hudson's Bay region is held by us to be economically dubious and financially impossible. Of just as much importance, and far more consonant with reality, is the relationship developed by members of several Departments with the Canada Centre for Inland Waters (Burlington, Ontario).

The Recommendations 4.1 and 4.2 on page A-57 are meaningless in view of the establishment of the 'fourteen central disciplines' policy by the Council of Ontario Universities, which has been accepted by the Committee on University Affairs. We quote from the Sixth Annual Review, 1971/72, of COU: *"emergent universities should offer some M.A. and M.Sc. work in the central disciplines, simply because they are universities....."* (page 15). At about the time that the first version of the Consultants' Report was written and published (March 1973) both Brock and Windsor were in the final stages of being approved for Government funding for M.Sc. programmmes. We object to defined time-limits for consideration of possible Ph.D. programmes on the grounds that individual Departments should be able to develop to that level of competence as and when the circumstances are appropriate.

We are also disturbed, however, by the implications of Recommendation 4,3. page A-57, with its

reference to accreditation. We reject the concept of individual accreditation unless practiced on a Province-wide basis, and even then we feel it would simply add to the burden of present day bureaucracy. We think that there ought to be wide recognition of the fact that the working scientist undergoes 'accreditation' continuously-every time he applies for a research grant (e.g. from the National Research Council) and every time he hopes to publish a paper in a refereed journal.

Naturally, we endorse recommendation 4.4, page A-57, who wouldn't?

The Recommendations 5: Leadership and Co-operation are written in such an equivocal style that we can neither endorse nor reject them. We are glad to read that the emphasis on environmental studies and various applications of the earth sciences, which we have been giving for some years now, has the approval of the Consultants. But the manner in which Recommend-ations 5.1 and 5.4 are written in such as to give a false impression of inactivity on our part. We claim that, within our system, there is already a position of leadership in environmental studies. Similarly it is unfortunate that the Consultants should apply the phrase '.... a more direct interest in .....' to activities which are an integral part of the earth sciences in Ontario.

As far as Recommendation 5.3 is concerned we note that the restrictions are largely on the part of the governmental and industrial organizations, mainly

because of excessive formality of administrative arrangements. We would welcome the development of a system in which active co-operation could be implemented and practical results achieved.

Again, in considering Recommendations 6, pages A-61, A-62, we must deplore the absence of a literary style which gives an accurate picture of what we are doing. A layman, reading Recommendation 6.1, would have no idea of the work already done by the Council of University Departments of Geology (Ontario). That body, surely, does not need to be told to do what it has being doing for many years. Inter- and intra-disciplinary combinations have been a focus of thought and action in recent developments and will no doubt continue to be so. There is no need for Recommendation 6.3 because we are well aware of the directions of change taking place in the earth sciences.

Under Recommendation 6.2(d), page A-62, we are asked to consider sponsoring system-wide speciality meetings. We already do this and have done so for years in such activities as Experimental Mineralogy and Ore Genesis, the Biostratigraphy Group and the Geotraverse Group. Clearly, the Consultants omitted the study of Departmental Bulletin Boards.

We concur with the view Recommendations 1: Projected Graduate Enrolments, pages A-50, A-51, that demographic projections and past enrolment patterns are the best bases available now for preparing forecasts of graduate enrolment in Ontario. We also agree with the

way in which the consultants have used those parameters to prepare their enrolment projections. However, we urge that the utmost caution be exercised in controlling the level of graduate programmes in the Province on the basis of these projections. We think that certain factors (political, social and economic) over which we have no control, exert an over-riding influence on actual levels of graduate enrolments. We strongly endorse Recommendation 1.5 with its emphasis on a continuing review of supply and demand.

We are, however, concerned that there should be no inconsistency between that Recommendation and Recommendations 2: Admissions Policies, page A-53, with which we entirely agree. If admissions are 'based solely on academic criteria' then we must forsake any plan which seeks to determine enrolment levels according to set planning criteria. We must, in fact, admit to a lack of control of those external forces already mentioned.

Of particular concern to us are the implications of the figures given in Table 5.5, page A-49, for the proposed distribution of graduate students in the Solid Earth Sciences for the academic year 1977/78. It is worth noting that Brock already has 8 M.Sc. students enrolled whereas the predicted number in the future is 4; Laurentian has 9 (plus 4 part-time students) whereas 5 are predicted; Waterloo has 33, whereas 24 are predicted; Windsor has 9 (4 in Geomorphology, 5 in Geology) whereas 4 are predicted. Apart from these details, there does not seem to have been any serious thought given to the relationship that exists between the number of professors in a Department, the

availability of research grants with which to support research students, the availability of scholarships (internal and external) and the space available to a Department. The restriction of space at McMaster, Toronto, Western and Carleton is decidedly a limiting factor in predicting increased enrolments of graduate students. And another limiting factor is the disturbance of the faculty: student ratio implied in the figures given in the table for the established Universities (but not apparently for Ottawa which, having 30 students now, is supposed to have only 31 in 1977/78). These are already becoming limiting factors because there is evidence that there is a greater supply of qualified applicants than can be properly accommodated.

We assert that Table 5.5, page A-49 must not become the planning basis for the Province.

4. In summary, while welcoming the mainly, approving and optimistic tone of the Report, we remain unhappy because of its many shortcomings. We recognize that the task set before the Consultants was one of immense difficulty. We think that the system will not be greatly enlarged in the next five or ten years, nor will it diminish in size, of itself. We think that the system will develop best if the intelligent people who make up that system play a significant role in and respond to the profound changes taking place in the solid earth sciences.

For the Geology Discipline Group,

Edward Mercy, Chairman,
Dept. of Geology, LAKEHEAD UNIVERSITY,
Thunder Bay, Ont.

November 22nd, 1973.

APPENDIX C

UNIVERSITY COMMENTS

Comments have been received from Carleton, Guelph, Lakehead, McMaster, Ottawa, Queen's, Toronto, Waterloo, Western Ontario, Windsor and York.

CARLETON UNIVERSITY

RESPONSE TO THE SOLID EARTH SCIENCES DISCIPLINE ASSESSMENT

Introduction

Carleton has previously expressed concern about assessment procedures which examine in isolation single disciplines or collections of sub-disciplines grouped arbitrarily for the purposes of assessment. We believe that groups of related disciplines should be evaluated in order to assess properly the situation within a single discipline. The Solid Earth Sciences report reinforces our concern over the piecemeal approach. Various fruitful interactions are continually developing between groups in different departments within the University, and also with researchers in other universities, in industry, and in government, and it is essential that the recommendations of consultants in one discipline be judged in part at least in terms of their likely effect on these highly productive linkages.

Because of our proximity to the University of Ottawa, we find ACAP consultants making a variety of recommendations ranging from closer cooperation to complete integration of Carleton's graduate programmes with those of the University of Ottawa. We need not repeat here the many instances of cooperation and co-ordination between the two universities already cited in the reports of the various consultants and we intend to pursue every reasonable opportunity to further this cooperation. But we believe that simplistic recommendations concerning the combining of programmes at the two universities require a more careful examination than they have been given by the consultants.

Our present response is directed to the second and revised report intended to replace an earlier report to ACAP on the Solid Earth Sciences by the same consultants. The revised report has been changed somewhat in presentation, in accuracy, and superficially in substance. The recommendations at the general level regarding admissions programme development, cooperation, and self-appraisal are reasonable enough.

At the level of recommendations for individual institutions, however, the report still reflects the substantial weaknesses in the original approach.

The discipline of Solid Earth Sciences because of its breadth and complexity is difficult to assess by a small number of consultants. Carleton, while recognizing this difficulty, must nevertheless express concern with substantial shortcomings in the present report. We consider that it is an essentially superficial, hurried report, that it contained no in-depth assessments of individual universities, that no advice was offered on plans proposed by each university for the planning period, and that certain conclusions or recommendations may be misleading. On the other hand, we welcome parts of the report, especially recommendations 2.1 and 2.2 on admissions policy, and 4.4 on the funding of research.

The data on which much of the report is based is now two years out of date, thus weakening many recommendations. Enrolment trends and employment opportunities have changed considerably in this two-year period, and that combined with the emergence of the energy crises, the shortage of certain metals and raw materials, and increased emphasis on environmental problems, have changed the significance of and the demands on the S.E.S.

The enrolment projections in Table 5.2 are probably realistic. It is hoped, however, that the proposed distribution of graduate students for the planning period as contained in Table 5.5, will not be adopted for planning purposes, because it is derived from "out of date" data, appears to contain errors, and recommended enrolments have already been exceeded at certain universities.

Currently the S.E.S. community at Carleton consists of a full-time faculty of 19, a part-time faculty of 7, 37 graduate students, and 139 major or honours students in the third and fourth years of undergraduate programmes. Our S.E.S. programme has developed a national reputation, if judged by the success of our students in national competitions, their admission to graduate schools, by the hiring practices of industry and government, by the involvement of its staff with scientific, economic, and social problems at the national level. Our research laboratories (mass-spectrometry, X-ray, experimental mineralogy, microprobe, structural, geotechnical, and geochemical analysis) are well equipped, and capable of investigating a great variety of scientific and practical problems.

The University, through its computer centre, science workshop (with a broad capability in instrument design, fabrication, electronics, and high vacuum techniques), staff in biology, chemistry, physics, and engineering, provides excellent ancillary resources. Carleton's programme, when divided into basic, applied, and management fields, is, as noted by the assessors, well balanced. Carleton intends to continue the development of its programme in the S.E.S.

Carleton's present graduate programme in the S.E.S., working from a strong undergraduate base, is concentrating on resource geology, Precambrian geology, structural geology and geodynamics, geomorphology, and geotechnical studies. We regret that Precambrian geology and geotechnical studies were not adequately investigated in the report. We are also concerned at the lack of specific comment on Carleton's proposed plans for developing its graduate programme in the S.E.S. during the planning period, at the lack of an individual assessment (rather than in combination with the University of Ottawa) of the S.E.S. programme at Carleton, and for the lack of more specific guidelines as to how the combining of the graduate programmes at Carleton and the University of Ottawa might be organized.

Development of Specialisms and Expansion at Particular Centres

Precambrian Geology. Carleton has substantial faculty strength and demonstrated accomplishments in Precambrian geology. We reiterate our intent to strengthen and further develop our programme in this area, and hope to do so in cooperation with the Geological Survey of Canada and the University of Ottawa. Carleton is particularly suited for this programme because of the research interests of its faculty, its location on the edge of the Canadian Shield, its proximity to the Geological Survey of Canada, and the Earth Physics Branch, Department of Energy, Mines, and Resources.

Geotechnical Sciences. Carleton cannot accept that its programme in this area is "largely invisible," especially if its teaching and research staff (glaciology, micrometeorology, pedology, fluvial and glacial geomorphology, and geotechnical aspects of soils) and research projects and laboratories in the Geography Department are examined, and when it is recognized that seven of the eleven graduate students working in engineering

geology (reporting subdiscipline) in the Ontario system in 1971-72 were at Carleton. One of the acknowledged weaknesses in the ACAP assessment is the manner in which the subdisciplines have been spread between the S.E.S. and Geography disciplines, which does not allow recognition of programmes like the one developed at Carleton. For example, climatology and hydrology are not included, and part of our soils (geotechnical) work is under the rubric of engineering geology.

The implication that Quaternary studies are only done at Brock is questionable in that most physical geography programmes, and especially the one at Carleton, have strong commitments to increasing our understanding of the Quaternary through geomorphological, glaciological and geotechnical studies.

Geophysics. Carleton concurs in the need for a third school of geophysics in the Ontario system and welcomes the recommendation that it be part of a Department of Geology that is already well qualified in economic and structural geology. We recognize that the Department of Geology at Queen's is a potential location for such a programme, but would suggest that Carleton is equally deserving and a more logical place to develop such a programme.

Carleton already has acknowledged strength in economic and structural geology. The proper development of these two areas, as well as Precambrian geology and cartography, require a stronger support base in geophysics than currently exists, and we must develop our support programme in geophysics in any case. Furthermore the proximity of the Geophysics Division of the Geophysical Survey of Canada, the Earth Physics Division, and the Canada Centre for Remote Sensing of the Department of Energy, Mines and Resources, and the pending move to Ottawa by several metal exploration companies offer many opportunities for cooperation and the sharing of staff, research and library resources. A strong and unique programme could be developed at Carleton that would make maximum use of the resources in the Ottawa scientific community.

Relationship with the University of Ottawa. Carleton has felt, and so argued, for the past five to seven years that the greater Ottawa

community needed only one Geology Department. With one Department an economic and academically strong unit could be developed that would maximize the use of staff, research resources, and contact with Federal agencies.

There has been long-standing cooperation between the two Geology Departments in planning graduate courses, supervising graduate students, sharing laboratory facilities and guest lecturers. This has more recently extended into staff procurement and subdiscipline development. A formal exchange agreement for graduate students between the two Universities now exists. The Geology Department would be happy to examine the feasibility of establishing an "Institute of Advanced Studies in the Earth Sciences" in Ottawa. Such an institute could result in effective cooperation at the graduate level not only between departments in the two universities but also could involve scientists in government and possibly industry.

The attitude of the physical geographers at Carleton is somewhat different. Because of their special interests, their team approach to teaching and research, and their relationship with the human and social geography programmes in the Department of Geography, and their research links with other Departments and Divisions within the University, the combining of resources could affect the existing balanced team structure to the point of weakening their effectiveness. As a group they would prefer to rely on existing cooperation rather than a formal integration.

The combining of graduate programmes proposed by the Assessors appears to have been conceived at the beginning of their investigation: "throughout our analysis we have tended to regard the two as a single unit." Carleton would have welcomed an individual assessment of its S.E.S. programme and the proposals for its development. Carleton would also have welcomed amplification of the reasons for the proposed integration and specific guidelines as to how the combining of the graduate programme in the S.E.S. might be effected. A consideration of questions such as the structural organization, financial arrangements, inter-unit relationships, the problems of distance, travel time and the nature of the organisms to be mated might have brought to the forefront some of the factors which have been totally ignored by the consultants.

A variety of relationships between a discipline at the University of Ottawa and its counterpart at Carleton are conceivable and it is likely the best relationship will differ from discipline to discipline. The range would seem to extend from the informal cooperation and sharing of courses, already in existence in many disciplines, to the establishment of an institute of advanced study under whose aegis a joint degree might be awarded. Carleton would be prepared to explore all of these possibilities with a view to discovering which are the most appropriate in each specific case.

SOLID EARTH SCIENCES CONSULTANTS' REPORT

University of Guelph Comments

The University of Guelph is in general content with the principles of the recommendations which pertain to the University. It is pleasant to acknowledge the commendatory tone of the paragraphs on page A-41 which report upon some of our activities. We take note of Recommendation 3.1 wherein the continued development of "pedology-geomorphology at Guelph" is supported.

We feel it necessary to express some concern that our program in geomorphology per se somehow seems to have been discounted. It is curious that the otherwise gratifying analysis on page A-41 is confined to pedology, making no reference to the work in geomorphology. The figures in Table 2.1 show, in fact, that the Guelph FTE faculty committed to geomorphology research and graduate instruction at 14.4 per cent of the total geomorphology effort are very close to Waterloo at 15.1 per cent, and both of them in turn not far below McMaster's leading 19.7 per cent. Guelph, with about 6 per cent of the current geomorphology graduate enrolment, clearly has substantial growth potential in that field (Tables 4.1 and 4.2).

It is because of the potential for growth that we had hoped to have some comment from the consultants upon our

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suggestion for a Ph.D. program at some future time to involve Soil Science and Geology and Geomorphology. The proposed graduate student distribution in 1977-78 (Table 5.5) appears to provide for some growth in Guelph geomorphology at the Master's level, but the Ph.D. figures cannot represent more than the growth in pedology urged in Recommendation 3.1.

The concluding sentences of the first paragraph in 4(a) on page A-28 are precisely what led us to expect some expression of opinion not only on the foregoing, but also on our emphasis on applied aspects of geomorphology and on our fundamental studies of geomorphic processes involving, for example, clay mineralogy. We interpret the consultants' rather oblique approach to mean that our geomorphology program should continue to develop along its present lines. But we find little assistance to our internal planning of that field in the report as it stands.

We are further concerned to find such meagre reference to Remote Sensing in this report. The very brief statement (bottom of page A-41) concerning "applications of remote sensing to land use problems and detailed studies of soil systems as they relate to waste disposal" is made in the context of soil science, plant science and animal science. There is no indication of recognition that the School of Engineering and the geomorphology group in the Department of Geography are both

.....

involved with the Department of Land Resource Science in this field, although it was our understanding that the SES consultants would be reporting on these developments at Guelph. The details were presented to them and discussed with them, and we explained the relationships here, in the belief that there is to be a subsequent "melding" of the Geography and the SES reports. As we then stated, the major effort is in the preparation of ground truth information to be used to interpret satellite photography, and substantial research funds have been obtained from USGS/NASA in this regard. The lack of comment in the Geography report is not surprising, but the omission of any reference to Remote Sensing in the SES report is disquieting. We suggest that this is but one field of several in which the Geography discipline group must be fully informed, and that it must have available to it for study the SES report -- and others.

As a final note of concern, we regret that no mention is made of our interdepartmental graduate program in Hydrology. At first blush it might appear that such a program is not relevant to a report on the Solid Earth Sciences. But we do find reference to groundwater specialization at other institutions, a field which shares common ground with Hydrology. We record, therefore, our continuing commitment to research and graduate study in this field, which is of vital consequence to our society. In the disposal of liquid wastes through our soil systems (bottom of page

.....

A-41) as well as in the recovery of potable and industrial water supplies from the ground, it should be evident that our agricultural engineers, our soil scientists, and many others have a contribution to make. We propose to continue to discharge these responsibilities as best we can.

We find interesting Recommendation 3.3 concerning Hudson's Bay. We place on record our initiation of muskeg/permafrost studies in this area and draw attention to a Symposium on the Physical Environment of the Hudson's Bay Lowland organized here in 1973. While we do not discount marine geological studies in that region, we suggest that they go hand-in-hand with other interdisciplinary studies of surficial materials which are of at least equal consequence.

The consultants' comments about inter-university cooperation in general, and about our cooperation with Waterloo in particular (page A-40) prompt us to testify to the mutual benefits arising from easy and regular exchange of faculty members and of graduate students. It may be necessary, in view of the consultants' seeming adjuration that "this collaborative activity should be recognized and encouraged by both insitutions", to state emphatically that both Guelph and Waterloo do indeed recognize and encourage what is genuinely regarded as a very worthwhile cooperation.

.....

By way of general comment, not specifically related to the University of Guelph, we support the principles involved in Recommendations 2 on admissions policies, although we would disclaim that the assurance of financial support can or should be a necessary condition of admission. We endorse the general, as well as the particular, points in Recommendation 3.1 with regard to "applied specialisms". We especially support the concept of "accredited supervisors" (Recommendation 4.3) and commend it as applicable in nearly all disciplines. And we emphatically endorse Recommendation 4.4 regarding the provision of funds for research independent of graduate programs, which also should apply to many disciplines.

A careful reading of the report discloses a number of apparent anomalies for one university or another. We leave to them the task of comment. But there are other points we wish to make.

We find it strange that the consultants would have wished to recognize Quaternary geology as a sub-discipline (page A-2) and contrast with it their almost aggressive approval (top line page A-37) that Precambrian geology was not so classified. Without decrying the economic and societal values of the surficial materials, it is nevertheless true that Ontario owes much of its present stature to the mineral wealth of the Precambrian Shield,

....

the study of which must continue in the future.

Table 2.4 contains some unexplained or incorrect numbers. The 134 continuing students of 1969/70 plus the 31 new ones total 165 (not 175 as shown for 1970/71). As a result there should be 135 (not 145) continuing students in 1970/71, and 126 (not 134) continuing students in 1971/72.

Table 2.7 sets out Libraries data for 1970-71. The categorization of the data is less than clear without some explanation of, particularly, the second and third columns of numbers. The assertion (page A-24) that the summary "indicates that the system is adequately served in terms of library holdings" would be more reassuring had the consultants discussed the matter more fully.

In conclusion, we reiterate our general satisfaction with the report. We strongly urge that ACAP take due note of our expressed concerns about Guelph's geomorphology, remote sensing, and hydrology. And we hope that there can be clarification of at least some of the points of criticism in the preceding few paragraphs.

****

November 27, 1973

TELEPHONE 345 2121
AREA CODE 807

Lakehead University
POSTAL STATION P, THUNDER BAY, ONTARIO, CANADA

December 18, 1973

Professor M.A. Preston
Executive Vice-Chairman
Council of Ontario Universities
102 Bloor Street West
Toronto 181, Ontario

Dear Dr. Preston:

The Department of Geology has carefully examined the Report of the Solid Earth Sciences submitted to ACAP and have a viewpoint which seems worthy of your consideration, as it is pertinent to the plight of a good department in a small University with respect to graduate work. This is especially important in this case as their study of Geology relates to our local environment. In addition, the department has over the past six years continued to expand. The faculty are keen to mount an M.Sc. programme and bring in more than adequate external grants to support M.Sc. students.

It would seem that rather than attempt to paraphrase the views of the department that it would be better to enclose the relevant part of their response to me, which I trust will receive your full attention.

Yours sincerely,

DR. A.D. BOOTH,
President

ADB/cac

Lakehead University

MEMORANDUM

TO: Dr. Andrew D. Booth,
President.

DATE: Nov. 29th, 1973.

FROM: Dr. Edward Mercy, Chairman,
Geology Department.

SUBJECT: Response of the Department of Geology to the Report of the Solid Earth Sciences Consultants to the Advisory Committee on Academic Planning, Ontario Council on Graduate Studies, Council of Ontario Universities.

There are two aspects of the Report which need to be considered. The Consultants approve the general academic situation on which they find in the Ontario Universities and forecast a moderate increase in the total numbers of M.Sc. and Ph.D. students in the system. These two aspects will be discussed together.

Present trends and future prospects for professional geologists in Canada may be seen in terms of a steady, continuing, but moderate growth in employment opportunities. The situation is such that Canada automatically attracts immigrant professionals year by year. It is true that the employment of some kinds of geologists is subject to the vagaries of variations in the economic and political sectors of the country's organization. But because of the increasing use of geologists by Federal and Provincial Governments such effects tend to have much less impact than hithertoo.

Those general statements can be substantiated by employment data from various sources. Evidently, the Consultants are conversant with the situation because they project increased enrolments in the Solid Earth Sciences not only in the first five year period but also in the second five year period. The basis of their argument is discussed on pages A-42 to A-52 and their Recommendations 1.1 to 1.6 are to be found on pages A-50 and A-51. From a 1971/72 total of 391 graduate students the Consultants recommend, for planning purposes, a 1977/78 total of 593 graduate students.

Unfortunately, from our point of view, they do not see growth reasonably spread throughout the Provincial Universities but concentrated in the major, highly developed institutions. The Recommendation 4.2, page A-57, is one to which we object most strongly. The paragraph in question shows lacunae in the Consultants' knowledge of the Ontario System. During the period in which the Report was being assembled both Brock University and Windsor University were in process of having their Geology Departments appraised by O.C.G.S. for

graduate studies at the M.Sc. level. As of September, 1973, both Brock and Windsor have governmental approval for their programmes. Laurentian University has had a Geology M.Sc. in operation since September, 1970. The suggestion that existing graduate programmes at the Master's level be re-appraised is inconsistent with the expressed intentions of the Ontario Council on Graduate Studies. The contention inherent in Recommendation 4.4 (research independent of graduate studies) is not one with which we agree and is unrealistic in terms of the attitude of the Ontario Government toward funding of the Universities.

The situation now is that Lakehead University is the only one in the Province which does not have a Master's programme in Geology. In view of the forecasted enrolment increases (which raise severe problems for the established Departments if the additional students are to be accommodated only in such places) the equitable position which ought to be taken by the Advisory Committee on Academic Planning is that an application from Lakehead University for M.Sc. level work in the Geology Department would be subject only to academic appraisal.

RESPONSE OF McMASTER UNIVERSITY

TO

THE SOLID EARTH SCIENCES CONSULTANTS' REPORT

In this revised final report the consultants have made a laudable attempt at answering many of the criticisms that were directed at their earlier report. The recommendations stand virtually unaltered but there is now a clearer and more useful statement concerning total enrolments (pp. A42-A50) and the proposed distribution of that enrolment (Table 5.5, p. A49). There is also an assessment of individual SES Units (pp. A33-A41) which previously did not appear in the report. We find this report overall to be a much more acceptable one than the earlier version.

Some sections of the report, in our view, have always been unexceptionable. Virtually all of recommendations 5 and 6, for example, are acceptable although we question whether the creation of an "appropriate agency" charged with attempting to remove or lower obstacles in the way of cooperation between University Units and government and industry (Item 5.3), might not simply add another level of bureaucracy in the system. Recommendations 6.2 (d) and 6.3 we understand, have been under consideration for sometime.

The crux of the report appears to rest in Item 1, specifically 1.4, and many of the subsequent recommendations are dependent upon these enrolment projections. Earlier, it seemed to us that the enrolments mentioned in recommendation 1.4 were probably high but two developments have altered our view of this question. The first is the marked upward pressure of graduate student applications and the second is the employment picture.

The Ontario SES system as a whole (1973-74) has an increased graduate enrolment and we understand that four Units have already exceeded the proposed 1977-78 enrolment levels. Here at McMaster the enrolment in SES is up over last year and we have experienced no shortage of good applicants. The quality of our students also has increased. In regard to employment, a shortage of jobs which appeared to be getting worse last year, seems this year to have almost vanished. Our own graduates, indeed, have experienced few difficulties in obtaining employment in recent years.

The forecasted enrolments, then, may well be achieved. Quite rightly the consultants emphasize that admissions should be based solely on academic criteria (Item 2.1) without undue financial constraints (Item 2.2). We welcome the general discussion in Section 5 on the enrolment projections especially in regard to the demands that may be placed on the major SES departments in the event that the total projected growth in enrolment does occur. We are certainly appreciative of the particular problems associated with the support of a field plus laboratory oriented subject like SES and we are prepared to meet the challenges associated with the further growth of the subject at McMaster.

We wish to comment on Recommendations 3. We make no comment on the particular plans of our sister universities for developing work in the areas of specialization which are named, but we do question some of the emphases implied in these recommendations. Specifically, we cannot agree that Quaternary studies, anymore than Precambrian studies (Item 3.1), are to be encouraged per se; rather they are areas of application of broad geologic techniques. Experience in many institutions suggests that narrow applied specialisms often tend to produce relatively inflexible people. This would be regrettable in any situation but in those subjects which bear on the

environment so directly as the Solid Earth Sciences such inflexibility would be disastrous. In Item 3.3 there is a recommendation concerning the development of graduate studies in marine geology with special reference to the Hudson's Bay area. We do not question the desirability of such a development but we do express regret that the consultants did not acknowledge the considerable involvement of SES groups such as our own here at McMaster in studies of Canada's northlands. Our geomorphologists, in particular, have been involved in work in the Arctic for many years and this programme will benefit in the future, from the greater involvement of other SES groups at McMaster.

The consultants in Recommendation 4.3 refer to a system of accreditation which we support in principle. We would note that here at McMaster there is already an involvement of non-McMaster persons in the partial supervision of some graduate students. Our experience suggests, however, that the accreditation involved is best regarded as informal and ad hoc, and quite often it is dependent upon personal and professional friendships. We believe that this is probably the way that it works best and we question whether formal accreditation of the type referred to by the consultants is likely to work very well.

In conclusion, we note with considerable satisfaction the consultants' estimate of the strength of SES activities at McMaster. We are also pleased to have their acknowledgement of the strong interdisciplinary nature of SES efforts at this University. It is the intention of our faculty and the University to maintain and whenever possible, to further strengthen these ongoing efforts.

UNIVERSITÉ D'OTTAWA
550, RUE CUMBERLAND

UNIVERSITY OF OTTAWA
550 CUMBERLAND STREET

OTTAWA, ONTARIO
Canada K1N 6N5

CABINET DU RECTEUR

OFFICE OF THE RECTOR

December 5, 1973

Dr. M.A. Preston,
Executive Vice-Chairman,
Advisory Committee on Academic Planning,
Ontario Council on Graduate Studies,
Council of Ontario Universities,
102 Bloor Street West,
TORONTO, Ontario. M5S 1M8.

Dear Dr. Preston,

This is a response to your request for our comments on the report of the Solid Earth Sciences to A.C.A.P.

The final report of Solid Earth Sciences assessment has many striking weaknesses which are only too apparent. Solid Earth Sciences are often defined as "the application of all other sciences to the study of the earth". It should have been apparent that three men, be they geniuses, could not, in the short time alloted, come near to the in-depth study that we were all hoping for. Many shortcomings of the report can probably be attributed to the special character of Solid Earth Sciences. Indeed, the consultants themselves quite rightly admit (page A-4) that "any study of this sort must be imperfect" and add that "it was not always clear that we had been completely informed about Solid Earth Sciences activities peripheral to the core subjects of geology, geophysics, and geomorphology." We should like to add that even when they were informed, indeed more than once in written statements, of the geomorphology component of Solid Earth Sciences graduate work at Ottawa, they chose to ignore it (see tables 2.1, 2.2, Figure 2.1, pages A-32, A-37), except in tables 4.1 and 4.2, which are inconsistent with tables 2.1 and 2.2.

The reason for the non-committal statement: "we are aware of no geophysics" (page A-37) is difficult to understand. We specifically informed the consultants that this was deliberate policy because this field is covered by Carleton University and our students go to Carleton for courses in this field. This is part of our long standing agreement on collaboration.

The area of Geotechnique is developing very well and, although no mention of this is made in the report, the consultants did talk to the new professor who had just been hired to cover this specialty, and to the chairman of the Civil Engineering department, who both indicated to them our interest in this field. We see no evidence of this in the report.

The comment (page A-37): "In the geography department there is an unusual, but highly commendable, integration with civil engineering, which produces work in applied geomorphology as this is understood in France" completely baffles us. We know of no factual basis whatever on which it could rest. What could, however, be said is that the geography and geology departments are continually working towards closer co-operation.

Projections of graduate enrolments, and even more their justification, are of course always risky. When the Science Council study on Solid Earth Sciences was undertaken (1968-69) there was a dearth of geologists in Canada. When the report was published in 1971 suggesting the need for more geologists in Canada, there were too many underemployed earth scientists. When the A.C.A.P. Solid Earth Sciences study began in 1972 future employment prospects looked gloomy. Now in 1973-74 the employment outlook is optimistic. This seesaw pattern has lasted for the past twenty years and can be expected to continue. The projected graduate enrolment for the University of Ottawa is given as 31 for 1977-78 (table 5.5). Since our geomorphology has been essentially ignored in the report, we could assume that this figure refers to geology alone. We do not at present envisage having by 1977-78 the physical laboratory or office space to accommodate this number of geology students. The figure would be more realistic were it to include geomorphology.

We regret the use of uncontrolled statistics as a basis for the unjustified conclusion that "the University is somewhat overextended in its Ph.D. programmes" (page A-37). Although a cursory view of the data for structural geology might appear to support their conclusion (0.65 FTE for 5 students) a careful examination shows that of the five students specializing in this area one was part-time and, in fact "dormant", one was two weeks away and another three months away from his thesis defence, one had been admitted only two months previously and another had been there for about eight months. Research supervision was at that time really needed by only two students. Every university has similar fluctuations from year to year. It should also be pointed out that the figures for M.Sc. and Ph.D. students at the University of Ottawa (page A-49) are presumably reversed and that instead of 20 Ph.D. and 11 M.Sc. students should read 11 Ph.D. and 20 M.Sc. students.

With regard to recommendation 3.5 (page A-56) it should be pointed out that collaboration between the Ottawa and Carleton geology departments goes back many years, during which there have been common shared courses and alternation of courses between the two universities. As a consequence, each has developed different aspects of the earth sciences and the total faculty of both geology departments displays little duplication. Combination of programs therefore would not be expected to result in spectacular financial savings. It should, however, be borne in mind, too, that both universities do not necessarily draw their students from the same population pool. In particular, with the increasing Frenchification of certain components of the Ontario secondary school system, the proportion of French-speaking students at Ottawa is increasing and can be expected to grow further. The University of Ottawa is a unique bilingual microcosm and any merging operations will have to respect this facet of its nature. Three years ago, after a thorough inquiry into the desirability of continuing the existence of our department of geology or of closing it down, a decision was taken to develop it on the condition that it emphasizes French language teaching. With this in mind, a French-speaking head was appointed and two other French-speaking professors have also been added to the staff of the department.

A small joint committee of the geology departments at the two universities is being set up to tackle issues that can be handled at that level and we expect the systematic progression towards improving the graduate studies environment in both departments to continue. It will probably not save a great deal of money, but it is well worthwhile. In addition, the departments of geology and geography at Ottawa University are establishing a joint approach to common topics such as geomorphology and Pleistocene geology. In both instances (geology-greography at Ottawa and geology Carleton geology Ottawa) success will come from common needs and joint interests of both departments. Any artificial structure imposed from above would be doomed to failure if it did not correspond to a real interest at the working level. The future of collaboration in the Solid Earth Sciences looks good and we can be optimistic. More important, however, is the implementation of recommendation 5.3 (collaboration with government units). We have no doubt that as this progresses the Ottawa-Carleton-Federal Government complex can become one of the best solid earth science centers in Ontario and in Canada.

Yours sincerely,

Roger Guindon, O.M.I.,
Rector.

copy: Dr. P. Hagen
Dr. A. D'Iorio

QUEEN'S UNIVERSITY

School of Graduate Studies and Research

QUEEN'S COMMENTS ON FINAL REPORT OF THE ACAP CONSULTANTS ON THE SOLID EARTH SCIENCES

November 22, 1973. Amended February 5, 1974

Final Report of the ACAP Consultants on the Solid Earth Sciences

The main focus of the terms of reference presented to the consultants, and of their response to these terms of reference, is the future development of graduate programs in the solid earth sciences in the Ontario University system. This development will be contingent upon changing levels of enrolment in graduate programs in the solid earth sciences which, in turn, will reflect changing patterns in career opportunities for graduates in the solid earth sciences. Any forecast of university enrolments or of the demand for postgraduate students on the employment market, is fraught with uncertainties. However, planning cannot proceed without such forecasts, and we in the Department of Geological Sciences agree with the method of analysis used by the consultants. We concur with their conclusion that their projections are conservative but, even so, are hesitant to endorse any large scale commitment of resources to meet the scale of growth in graduate enrolments which they predict.

The specific recommendation which they make with regard to growth in graduate enrolments in the solid earth sciences at Queen's University (Table 5.5, page A.49) is a matter of great concern to us. In view of existing university policy regarding total growth in enrolments at Queen's, and of our "intuitive" forecasts of future demands for admission to graduate studies at Queen's, the proposal that the graduate enrolments in the solid earth sciences at Queen's be increased to 112 by 1977/78 seem quite unrealistic, as does the conclusion that our minimum enrolment of graduate students in the solid earth sciences in 1977/78 should be 96. We do not think that we can accommodate a growth in graduate enrolments beyond that which we forecast in our submission to ACAP on May 12, 1972. At that time we indicated that our graduate enrolment might grow to a total of 85 students by 1980 and that the corresponding growth in faculty would be from 17 in 1972 to 29 in 1980. We have re-examined our position with regard to growth in graduate enrolments and the results of this analysis are tabulated on a page attached to this memo.

Our current estimates of maximum growth in graduate enrolments, as tabulated on the attached page, do not differ significantly from those which we submitted to ACAP. The growth rate for our department follows closely the growth rate for the entire Ontario system as forecast by the ACAP consultants. Our forecast for 1977/78 is 77, substantially less than the 112 recommended by the consultants or the 96 which they propose as a minimum. There is a strong feeling among some of the faculty in this department that even this level of growth would seriously impair the quality of our graduate teaching and research. Accordingly, I would suggest that our estimates be viewed as maxima which would only be attained if there is a substantial increase level of qualification of applicants for admission to graduate work in the department.

November 22, 1973. Amended February 5, 1974.

We concur with the ACAP Consultants' recommendations on admissions policies.

We are considering the recommendation that a third major geophysics group for the Ontario system be established in the Department of Geological Sciences at Queen's University. This could be accomplished by increasing the faculty component in the field of geophysics from two to perhaps five, as outlined in our May 12, 1972 submission to ACAP, or six. It would involve some minor adjustments in our priorities for fields of specialization in growth of the faculty in the Department of Geological Sciences. However, we appreciate the fact that any growth in faculty will be related to growth in enrolments, and therefore, we would not expect to develop this strength in geophysics much before 1980. Moreover, it should be pointed out that research in geophysics involves large expenditures for equipment, and any development in this field will be contingent upon budgetary conditions in the University.

Although the consultants' forecasts of growing enrolments in the solid earth sciences graduate programs in Ontario could be interpreted as a basis for encouraging the development of graduate programs at a Ph.D. level at Brock, Lakehead, Laurentian, and Windsor, we are concerned about the reliability of these forecasts, and therefore, accept the consultants' recommendations that Ph.D. programs in the solid earth sciences should not be considered for these institutions during the first five year planning period.

We agree with the proposal that mechanisms be developed to accredit individuals at universities other than their own, where the Ph.D. program in the discipline is offered, to direct graduate work, and that funding be made available by the Ontario government for research independent of graduate programs.

We have no comments to offer on the consultants' recommendation on "leadership and cooperation" and "self-appraisal", except to point out that:

(1) The Department of Geological Sciences at Queen's University is involved in interdisciplinary environmental studies (including some research on the Hudson's Bay area)

(2) Some of our research equipment is available for use by workers from nearby centres (electronprobe microanalyzer) or shared by the University community at large (scanning electron microscope), and

(3) There is a substantial cooperative effort at Queen's in the field of gectechnique and engineering geology, but this was not evident because the data supplied to the consultants did not include any mention of activities in the field of civil engineering and mining engineering.

R. McIntosh

R. McIntosh
Dean
School of Graduate Studies and Research

RM/mjc

UNIVERSITY OF TORONTO
School of Graduate Studies

OFFICE OF THE DEAN

Toronto 5, Canada

December 10, 1973

Dr. M. A. Preston,
Executive Vice-Chairman,
Advisory Committee on Academic Planning,
Council of Ontario Universities,
102 Bloor Street, West, 3rd Floor,
Toronto, Ontario,
M5S 1M8.

Dear Dr. Preston,

The University of Toronto remains disappointed in the quality of the report submitted to ACAP by the consultants in Solid Earth Sciences, in spite of the additions made to the earlier version of the report. While we welcome the general optimism of the consultants concerning the future of solid earth sciences in this province, we cannot see that their additional comments on the individual departments and programs provide much of a basis for evaluation and planning.

The Solid Earth Sciences Report points up, in particular, the problems arising from lack of integration of reports in contiguous and overlapping disciplines. This can lead to misunderstanding of the strength of a discipline on any one campus or the superficial treatment of any area not considered central, in the opinion of the consultants, to a particular discipline. This seems to be the case, for example, with geomorphology, which is given little attention in the Solid Earth Sciences documents. The University of Toronto plans to make further comments on this aspect when all reports of related groups are in.

The recommendations

1.1 The technique used by the consultants for the projection of enrolment (p. 45) is so crude that one cannot have confidence in it, and that given on p. 50 is not explained. One wonders what point is served by asking consultants of such different backgrounds to continue to make projections of such varying quality.

1.6 This recommendation gives no guidance on how to effect a reduction, should one be necessary. A comparative evaluation of departments would have given COU a basis on which to concentrate work in strong departments, should that be necessary, as well as helping with the planning function within each university.

2.1 We agree.

2.2 We agree.

3. In the preamble to these recommendations it is not clear what the consultants mean by critical size, in spite of their earlier discussion on pp. 22 and 23. Critical size can be determined by several factors (faculty, students, facilities, strength in related disciplines, etc.) and a clearer statement would contribute greatly to the value of the report.

3.2 We understand that this question is being discussed by the chairmen of the Ontario departments of geology and other earth sciences.

3.3 The Department of Geography has three graduate students working in coastal geomorphology and three staff members are interested in working on coastal geomorphology, hydrology and oceanography in the Hudson Bay area. However, financial resources are lacking for developing this interest further.

3.4 The University is in sympathy with developing, within our financial capabilities, SES facilities at Erindale and an orderly expansion is taking place. Within the next two years, we expect to have 7 F.T.E. faculty at Erindale, most of whom will be doing some graduate teaching on the St. George Campus.

4.3 We have serious reservations about this recommendation as phrased here. It appears to brush aside critical size despite the earlier (too general) discussion of it. It is not clear how individuals could direct graduate work at another institution without, at least in some cases, moving the student or the faculty member. Other problems of both an academic and a practical nature could arise. Given the expectations this far-reaching proposal will raise, the consultants might have been expected to examine its consequences and implementations.

5.1 We are surprised that there is no reference in the report to the Institute for Environmental Studies and Engineering at this University, which was specifically set up to fill such an interdisciplinary rôle as is mentioned here.

The University of Toronto

The consultants remark on the poor housing of the geology and geography departments, a problem of which the University is fully aware. We would point out that this is only one more case where the government's restrictions on new capital funding penalizes older institutions in which renovations are badly needed.

Yours sincerely,

A. E. Safarian

:erb

A. E. Safarian,
Dean.

Response of the University of Waterloo to the Report of the Solid Earth Sciences Consultants to the Advisory Committee on Academic Planning submitted to ACAP, November 30th, 1973

General Comments:

The University of Waterloo finds the report of the Solid Earth Sciences consultants to be generally acceptable. We also wish to record our support for the general recommendations contained in the report. The report includes a useful survey of the graduate and research activity in this field in the various departments in the province although, in this respect, the report would have been more useful for planning purposes had the consultants given a more critical appraisal of the strengths and weaknesses of the various departments. The consultants' enrolment forecasts seem to us to be reasonable. The consultants' recommendation that individuals in universities which do not have accredited programmes should be able to be involved in graduate supervision through arrangements with other universities has considerable merit. This idea should certainly be explored by the discipline group.

Specific Comments:

In the section of the report devoted to the University of Waterloo, the consultants have recognized the strength of this university's Earth Sciences Department in the area of groundwater geology and associated studies. They recommend that the University of Waterloo's Ph.D. programme in this field should be funded. They suggest that this would require appraisal by acknowledged experts in this particular sub-discipline. We wish to point out that the Ph.D. programme in Environmental Geology was appraised in late 1971 and received approval from the Appraisals Committee of OCGS in the areas of groundwater geology and engineering geology. It seems to us to be unnecessary to reappraise the programme so soon after it was appraised, particularly since Ph.D. programmes are subject to reexamination in the normal course of the OCGS procedures in any case.

In Table 5.5 on Page A-49, the consultants present a proposed

distribution of graduate students for 1977-78. The proposed number of Master's students for the University of Waterloo is 24. The present Master's enrolment in this programme is 32 full-time students and the university's long term projections are for an enrolment of between 25 and 30 by 1977-78. Allowing for some reasonable spread in the figures, the consultants' proposal is therefore not inconsistent with the university's own planned enrolment at the Master's level. The figure the consultants propose for Ph.D. students, however, is somewhat surprising. The consultants suggest 2 students in the programme. This is the current enrolment in this programme and this may have been the source of the consultants' figure. However, we should like to point out that this is an artificially low number because the programme has not been funded and the university has deliberately kept the enrolment small. When this programme is approved for funding, we would plan to enrol between 6 and 10 Ph.D. students giving rise to an annual output of 2 to 3 Ph.D.'s per year. The consultants have recognized the important role which this specialized programme should play in the provincial plan for Solid Earth Sciences. It would be consistent, therefore, to recommend an enrolment that would maintain the programme at a viable level. We therefore recommend to ACAP that the university's planned enrolment of 6 to 10 Ph.D. students be accepted.

The consultants refer in Recommendation 5 to the desirability of establishing more cooperation between university units and governmental and industrial units and also of the desirability of developing links with work in geotechnic, engineering geology and resource related studies. We endorse these recommendations. The Earth Sciences Department at the University of Waterloo has developed and is continuing to develop strong ties with both industry and government agencies. There is also cooperation between the Earth Sciences Department and groups in the Faculty of Engineering and the Faculty of Environmental Studies. These links will continue to grow and develop as the department's doctoral programme develops.

Comments on Recommendations:

The consultants present a number of recommendations. We find ourselves in agreement with the recommendations that are of a general nature and apply to the entire system and in agreement with the specific Recommendation 3.1

which refers to the programme at the University of Waterloo. We make no comment on those recommendations which refer specifically to the programmes at other universities.

Response of the University of Western Ontario to the Report of the Consultants in Solid Earth Sciences of the Advisory Committee on Academic Planning.

November 28, 1973

This response of the University of Western Ontario to the ACAP Consultants' Report on the discipline of Solid Earth Sciences has been generated by a Special Senate Committee established for the purpose.

The Committee which reviewed the original Solid Earth Sciences ACAP consultants' assessment examined again the revised report. We note with some satisfaction that the original report has been substantially modified and that the inappropriate comments made about graduate students as individuals have been removed from the report. However, there remain many points on which the consultants have failed to commit themselves. The consequences of these omissions make the report a rather superficial document. A number of these points were commented upon by the committee at the University of Western Ontario on April 10, 1973 and with the exception of numbered paragraphs 1 and 2 we believe that all of the comments made at that time remain relevant.

I. Enrollment Projections

Enrollment projections seem to have been developed on a demographic base recognizing fundamentally a parallel increase between the students of Solid Earth Sciences and the 18-24 year age group. Some small adjustments have been made by the consultants to increase the number of students attending University and the fraction of graduate students studying the Solid Earth Sciences but this has little effect on the actual projections. The recommendation number 1.2 (A-50) of an increase of about 7% per annum in the first five years and 4% in the second five years of the next ten years seems to be founded entirely on demographic considerations. It totally fails to recognize the impending crisis in energy production and the central role that geographers, geologists and geophysicists may be expected to play in the alleviation of the perceived world-wide energy shortage. It is the view of this University that the projections made are most conservative and must surely be viewed as minima at the very best.

II. Students and post-doctoral fellows

The committee expressed strong support for the provision of scholarships for undergraduate students in the Solid Earth Sciences. They were firmly of the opinion that currently available support for graduate students is insufficient and as noted in our previous report (#5) we believe that some continuing support should be made available for the maintenance of post-doctoral fellows. In this context the committee would therefore support recommendation 4.4 to ensure that adequate operating budgets are available for the operation of the Solid Earth Science programs.

The reservations expressed by the consultants about the ability of the Universities, in particular Toronto, Western and MacMaster (A-47) to accommodate additional students seems to be unfounded on any statement made by this University and the committee strongly affirms its previous statement (#3) that, should a need arise, the departments concerned would be prepared to expand to meet it.

Finally we should like to mention that this University has conducted a summer program in the Earth Sciences open to teachers in the secondary (and to a lesser extent primary) schools for the last four years involving some 86 school teachers. This program is offered to inform teachers of recent changes in the field of Solid Earth Sciences. It is not unreasonable to expect that this program will lead to an increase in the number of students seeking training in the Solid Earth Sciences in the next five years.

III. Comments about the University of Western Ontario.

The consultants expressed the view (A-36) that the group at Western are primarily expert in Geomorphology. It is the view of the Group that Geomorphology is a large specialty. They are primarily active in the area of Quaternary Geology and not in the whole area of Geomorphology.

The consultants failed to identify, although the information had been provided to them in the ACAP report, evidence of active Geochemistry. We would point out that no fewer than 6 members of staff regard as their area of specialty Geochemistry. A copy of the departmental brochure indicating staff potentialities is attached which supports the view that substantial Geochemistry is proceeding in the department of Geology.

The committee repeatedly commented on the failure to recognize all manner of specialized facilities and although recognition is made of the high pressure equipment no comment is made about x-ray petrography, low temperature geochemistry, the data storage and retrieval techniques developed at this University and now used nationally, or the application of Mossbauer spectroscopy in the field of Geology. Similarily in the area of Geophysics, the study of geochronology, seismology, geomagnetism and heat flow have been totally overlooked. In effect the report is superficial and not suited to the purpose for which it has been prepared. The comment was made that, were the departmental labels attached to department descriptions (pp. A-33-36) removed, the four departments would be virtually unidentifiable to individuals familiar with these departments.

IV. National Environmental Research Council Report on Research in the Geological Sciences.

By contrast with the report on the Solid Earth Sciences we enclose herewith a document published by the National Environmental Research Council in September, 1973.

It is our view that the approach followed by NERC has yielded a more useful assessment of resources than has that of the Solid Earth Science Consultants.

UNIVERSITY OF WINDSOR

WINDSOR, ONTARIO N9B 3P4

TELEPHONE: AREA CODE 519
253-4232

Graduate Studies

February 6, 1974

Prof. M.A. Preston
Executive Vice-Chairman
Advisory Committee on Academic Planning
Council of Ontario Universities
130 St. George Street, Suite 8039
Toronto, Ontario M5S 2T4

SUBJECT: Publication of Solid Earth Science University Comments

Dear Mr. Preston:

We wish to have included for transmission to COU our Spring response in addition to the comments for the December, 1973 deadline.

For your convenience I have attached the total comment as we wish it to appear in the ACAP report to COU.

This includes (1) our original comments updated to include the new page numbers caused by the retyping of the consultants' first report followed by (2) added comments resulting from additional discussion of the consultants on pages A33 - A41.

Yours truly,

C.P. Crowley, Ph.D.,
Dean of Graduate Studies

CPC:mp
Encl.

Comments on the Report of the

SOLID EARTH SCIENCES CONSULTANTS

to the A.C.A.P.

The SES report to ACAP can be considered, on the overall basis, as favourable to earth sciences at the University of Windsor. However, it is clear from the Terms of Reference (item 3c, A-5) and from the consultants' own understanding of their objectives (A-2, ln. 9) that they have somewhat exceeded their mandate in making recommendations concerning Master's programmes. Nevertheless we concur with their sentiment that the proposed Master's programme in Geology and Geological Engineering should be thoroughly appraised to assure that it will fulfill a real need in the SES system. Based on the evaluative criteria set out in this report, we believe that the Department of Geology at Windsor meets and exceeds their stated criteria in all aspects, as shown in the following section:

1. Location

Windsor is the 11th largest city in Canada. Because of its location in the extreme southwestern end of Ontario, more than 500,000 Ontario residents live closer to the University of Windsor than to any other Ontario university. The rapidly expanding undergraduate base of the Department of Geology is clear evidence that this population has not been adequately served in the past and will support increased service at the graduate level in the future. In terms of population base, Windsor ranks after Toronto-St. George campus, Toronto-Erindale campus and Mc Master, about equal with Western Ontario, and ahead of the remaining eight SES centres. In terms of distance, the nearest SES department is Western Ontario which is about 120 miles from Windsor.

2. Undergraduate Base

The consultants recognize that Windsor has developed an "adequate undergraduate base" (A-22, ln.44). This is somewhat of an understatement. The major and non-major enrolment in first-year courses at Windsor is rapidly expanding:

Year	68-69	69-70	70-71	71-72	72-73
Enrolment	58	170	188	338	556

The current total of 556 places Windsor in first position amongst the 14 SES geology and geophysics departments in Ontario unless Toronto St.George (Geology) has a higher total. The latter department did not report a figure to CUDG(O) this year. We expect the total to increase next year because of a new course offering to all first-year Engineers.

In the category of 2nd, 3rd and 4th year major students, the Department of Geology at Windsor has shown substantial growth:

Year	68-69	69-70	70-71	71-72	72-73	Projected 73-74
Majors	6	15	32	39	49	60

The current total of 49 major students ranks Windsor as 8th of the 14 SES geology and geophysics departments in Ontario, and only seven students short of sixth place. Further, because of the greatly expanded first year base, the increased total of first year declared majors, and the present distribution of major students by year, it is apparent that the Department will have a continued rapid growth in major students for the next few years.

The consultants suggest that a "hypothetical full-fledged undergraduate base might reasonably aim at ... 300 or more first-year undergraduates, and 50 or more declared majors in second to fourth years." (A-22, ln. 36). Only Carleton, Queen's, and Toronto (St. George) Geology meet both standards, while Windsor is but one major student away from meeting both standards.

Faculty and Facilities

The consultants have made no real attempt to evaluate faculty competence and facilities (A-4) which is quite correct in view of the haste of their visit (i.e. one consultant spent less than one hour talking to faculty in the Department). Both the consultants (A-47, ln. 46) and ourselves recognize that our claim to faculty academic competence and requisite facilities to man the proposed Master's programme resides with our OCGS appraisers. The consultants are incorrect in recommendation 4.2 (A-vii and A-57) in suggesting that the programme had been previously appraised. The Department is currently in the process of being appraised for the first time OCGS, and we will rely on the appraissers' judgement in these matters.

The consultants are vague on the number of FTE faculty required to man a Master's programme. In one place for example they suggest that a "full-fledged undergraduate department might reasonably aim at ten or more faculty members" (A-22, ln. 35) and shortly thereafter suggest that same department with the 10 or more FTE faculty could man a master's and doctoral programme with 20 or more graduate students (A-23, ln. 26). We suggest the adoption of CUDG(O) scale of 7-9-11 FTE faculty for running undergraduate-master's-doctoral programmes respectively (A-23, ln. 5) which was based on experience of successfully operating geology departments in Ontario. In this regard the Department of Geology in Windsor will have for the upcoming academic year 8.5 FTE faculty plus two permanent laboratory instructors (1 PhD and 1 ABD). The department thus meets the standard for a Mater's programme.

Areas of Specialization

The consultants contend in recommendation 4.2 (A-vii and p. 57) that the proposed Master's programme in Geology should select carefully the "areas of specialization, in relation to both the SES system and to the location of a given unit." We agree with them. The Department of Geology's proposed Master's programme will specialize in petroleum geology, industrial minerals and the engineering geology of solid rock. Their staff is strongly biased to develop this area of speciality. The consultants have emphasized the need for increased study of fossil fuel or hydrocarbon resources which is petroleum geology (A-26, ln. 7 and A-27, ln. 7), of industrial minerals (A-26, ln. 7), and of engineering geology and geotechnique (A-29, ln. 13) all of which are undeveloped or non-existent in the SES system. We conclude therefore that the consultants, just as CUDG(O) has previously done, recognize the need and support Windsor's desire to develope in these areas of specialization. With respect to the "location" caveat of their recommendation, Windsor is uniquely sited in Ontario's sole fossil fuel producing area and its major hydrocarbon refining area. The major economic minerals of our area are industrial mineral resources. Finally, Windsor is a centre of considerable Engineering Geology e.g.: the ever present foundation problems of glacial clays; the flat topography causing drainage and flood control problems and dams and pumping problems around our low shoreline, and the Detroit River shipping channel problems. Further, the Department of Geology through its Engineering programme has continuing research co-operation with Civil and Materials Engineering faculty who have interests in geotechnique.

In conclusion, we believe Windsor is an eminently sensible location for developing our proposed areas of specialisation.

Student Need for Master's Degrees

The consultants recognize that the Master's degree has become a valuable and increasingly necessary terminal qualification for a practicing professional geologist (A-46, ln. 42). As their report shows 93 students started Master's programs in the SES system in 1971-72. CUDG(O) figures show that about 184 bachelors degrees in geology and geophysics were awarded in 1971-72. Realizing that about 1/3 of these graduates leave geology for other careers, and that the number of students seeking Master's degrees outside the province will about equal the number entering Ontario, it is evident that about 2/3 of those students intending to practice geology as a profession wish to get a Master's degree. It is not in the best interest of the SES system in Ontario, nor of the various parts that make up that system--the students, the faculty, and the university, to prevent any department, with adequate student base, facilities, and staff from offering a Master's programme. The undergraduate body is deprived from desired interaction with the graduate students. The faculty is deprived of the challenge of directing graduate research. The student wishing to continue his studies at a given centre but who doesn't wish to go elsewhere for social, economic, or personal reasons, is deprived of higher level of education.

In closing, we would like to commend the consultants for completing a complex and arduous task, and to thank them for

supporting Windsor's efforts to fill a void in the SES system by proposing to offer Master's programme in the fields of petroleum geology, geology of industrial minerals, and engineering geology.

March 30, 1973

Dr. P. P. Hudec
Acting Head
Department of Geology

Page references changed.
November 15, 1973

Dr. D. T. A. Symons,
Chairman
Department of Geology

Added

Comments on the Report of the

SOLID EARTH SCIENCES CONSULTANTS

to the A.C.A.P.

The report is virtually unchanged from the original report submitted on March 10, 1973 by the consultants except for the addition of pages A-33 to A-41 which comment on each university in turn. Accordingly, we re-submit herewith the original "Comments" of March 30, 1973, with only the referenced page numbers changed.

The following additional comments should be made. First, the report is even less useful than the original in that the last data base year 1971-72 is now more distant history representing only the last of a five year data base. Our Geology and Geography Departments, like most other departments, are currently planning their graduate programs for the next one to three year period. A Master's student brought into these departments next year will not be available for employment until 1976 in all probability. If he wishes to further undertake a Ph.D. program, he will not be available until well after the end of the planning period in 1977.

Second, the Geology Department agrees with the consultants that petroleum geology (p. A-40, ln. 41) is a large specialty which we do not pretend to cover entirely. We currently have two staff members working specifically in aspects of petroleum geology. We believe that when any group declares a specialty such as petroleum geology or geomorphology, that it is well understood that not all aspects of that specialty can possibly be covered. The Geological Survey of Canada employs some 300 research scientists and does not claim to "cover" all aspects of all specialties. We believe the consultants would agree that a rational "restriction" is in our specializing in sub-disciplines of petroleum geology such as reservoir engineering. Trying to specialize in such a restricted geological setting as the Niagara Peninsula is like putting a fence around a rainbow--geoscientists tend to work in subdisciplines and not geographic areas.

Third, recommendation 4-2 on page A-57 (ln. 19) is inappropriate with respect to Windsor. When the consultants initially wrote the report, the Geology Department did not have a Master's programme--hence re-appraisal was impossible. However, last June we received OCGS-COU appraisal and accreditation for our Master's program in Geology. Surely it is not intended that this program should be reappraised. This is yet another example of how badly this report is out of date.

Fourth, recommendation 4-1 on page A-57 (ln. 12) suggests that Geology at Windsor should wait until the end of the 5-year period before our "potential" is assessed for a Ph.D. program. This would be an unwise policy. Putting a probable time-table of five years minimum to next ACAP appraisal, plus two years for OCGS-COU appraisal and accreditation, plus three years to first out-put of a Ph.D. candidate if approved, this recommendation would establish a full decade of delay. This delay would be incurred regardless of the faculty competence, student demand, industry demand, etc., in our fields of specialization. It must be pointed out that the report has made no attempt to assess Canada's requirements for graduate specialists in the various fields and sub-disciplines of the SES system. For example graduate paleontologists cannot be easily converted to engineering geologists if Ontario and Canada need the latter in the next five or ten years time. Indeed the report complements our several excellent centres of paleontology such as McMaster and Western Ontario and deplores the lack of centres for engineering geology. The question is really which subdisciplines will we need in the next few years and where in the SES system do we have the expertise to train the required specialists.

The consultants' proposal to accredit individuals for giving graduate programs is not accepted practice anywhere at present; is unworkable in our view, and is unlikely to be established in the forseeable future. We believe that appraisals and accreditations should go forward with each program being evaluated on its merits.

Fifth, whilst the two geomorphologists in the Geography Department welcome the suggestion of appraisal to help us to be "more effective", we note that some misunderstanding of the program is implied in the consultants' further comment (A-32, ln. 13 and A-41, ln. 13). Geomorphology graduate work in the Geography Department was entirely responsible for the graduate student count reported to the SES consultants for Windsor. Since then Geology has embarked on graduate studies and adjustments between the Geography and Geology programs are presently being made. The geography group had been active for only three years when the returns were made and had purposely set somewhat limited research objectives while equipment and facilities were gradually acquired. Five Master's students were enrolled into the geomorphology program of whom four were part-time students who could not reasonably be expected to complete the course and thesis requirements in much less than two to three years. We expect that not more than three Master's students per year will be admitted to the Geomorphology program. The program concentrates on coastal geomorphology and groundwater in relation to the lower Great Lakes. This program is compatible with the interests of the Geology Department and it is an area of study specifically pointed out as needed and lacking in the Ontario SES system (p. A-33, ln. 20).

Sixth, the consultants have simply proposed the fossilization of the

status quo in SES programs in Ontario universities. All universities should be appraised by field or subfield specialties for competence, etc., rather than by their grandfather or emergent status.

D. T. A. Symons

November 15, 1973

DTAS:lb

Dr. D. T. A. Symons
Chairman
Department of Geology

YORK UNIVERSITY
4700 KEELE STREET
DOWNSVIEW, ONTARIO, CANADA

FACULTY OF GRADUATE STUDIES
OFFICE OF THE DEAN

April 18, 1973.

Professor M.A. Preston,
Executive Vice-Chairman, ACAP,
Council of Ontario Universities,
102 Bloor St. W.,
Toronto 181, Ontario.

Dear Mel,

York recognizes that the final consultants' report in the Solid Earth Sciences is consistent with the examination of the geology activities in Ontario to which the consultants were specifically directed. Though a relatively narrow interpretation of "geophysics" was appropriate to the immediate purpose of the consultants, York prefers a broader definition, such as that of the International Union of Geodesy and Geophysics which encompasses the fluid aspects as well as the dynamical behaviour of the fluid and solid parts of the earth and its relation to the solar system. This latter type of definition is more consistent with York's activities in this area.

The consultants have only seen a part of the total earth science and geophysical activities conducted in Ontario. For example, applications of the social, physical and biological sciences to the study of environmental problems have been under way at York for some time. In earth science, remote sensing together with other advanced and novel techniques are being applied in physical limnology, atmospheric and aerosol physics and boundary layer meteorology. It is appropriate to observe that many of these activities will form part of the Physics ACAP review under the Atmospheric and Earth Science section. Indeed, it may well be that it is in this area of development that can be found the freshness of approach in interdisciplinary work to which the consultants drew attention though they were not in a position to observe it. Nevertheless it would be unfortunate if views expressed in the report (e.g. 3.2, p.69) should later prove to restrict proper and sensible development of modern approaches to earth and atmospheric science studies in universities, which did not come within their terms of reference.

The University has reservations about the consultants' views on accreditation, which if adopted would tend to favour existing larger departments and might jeopardize the future development of smaller departments which might legitimately expect to be involved in graduate work in limited areas. The benefit that a graduate student receives from his PhD work depends very strongly on the vitality and competence of his main supervisor as well as on the formal aspects of a graduate programme. There is merit in considering that accreditation should better be applied to individuals and not necessarily to institutions, particularly where there are opportunities for interdisciplinary and cross-disciplinary work. In fact there may be positive advantages to be gained in moving some established SES departments located in relatively uninteresting geological regions to developing and geologically interesting regions, such as the Lakehead and Laurentian, rather than to employ the limiting accreditation principle to these currently smaller departments.

This note constitutes York University's response to the final report of the consultants. The University reserves its own final position until the recommendation of ACAP itself is known.

Yours sincerely,

Michael Collie,
Dean,
Faculty of Graduate Studies.

A P P E N D I X D

PROCEDURE OF PLANNING STUDY AND TERMS OF REFERENCE

Procedure for Solid Earth Sciences Planning Assessment

21 January, 1972

The basic fields to be covered by this assessment are: Geology, Geophysics, Geochemistry, Physical Geography as related to solid earth sciences (i.e. Geomorphology and Pedology), and Geotechnique. The discipline groups involved are those in Geology and Geography, and to some extent, Physics. A Task Force formed from the Geology and Geography Groups will be needed for certain detailed work (4 from geology and geophysics, 2 from geography).

A. Tasks Requested from Discipline Group (with help available from ACAP at all stages)

A.1. The "major divisions" of study referred to are those shown in item B.1. They define the scope of the study.

A.2. Suggest suitable consultants. This also will be a matter for discussion with ACAP. (Lists submitted January, 1972.)

A.3. (Task Force). Examine and comment on pro formae to be used for the gathering of information on current, past and future programmes as described in paragraph B.1.

A.4. (Task Force). Examine and comment on the adequacy of the data on current and past strength.

A.5. (Task Force and Discipline Groups). Both in consultation with ACAP and separately, consider the situation revealed by the tabulation of proposed future programmes and consider whether future plans should be modified or developed in more detail. As a result of this step, individual universities may wish to revise the material described in B.1.d below.

A.6. Possibly develop a tentative plan for development of established or new graduate work in solid earth sciences in Ontario. Any such plans will be reported to ACAP which will transmit them to the consultants.

B. Information from Universities

B.1. Each university is asked to supply to ACAP, in the form indicated by ACAP after comment by the discipline group (paragraph A.3) information as follows:

a) for each major division, viz. Mineralogy, Petrology, Paleontology, Stratigraphy, Structural Geology, Geophysics, Geochemistry, Sedimentology, Geomorphology, Economic Geology, Environmental Geology, Marine Geology, and Pedology.

(i) current list of faculty members showing fraction of research and graduate instruction time devoted to

the division (for part-time professors show the time spent on university duties);

(ii) numbers of full-time and part-time faculty members for each of the past five years;

(iii) for the current year and preceding five years, number of (1) master's and (2) Ph.D. candidates doing research in the division; full-time and part-time shown separately.

Under these three headings one individual may appear under more than one category.

b) for each "department"

(i) Curricula Vitarum of all faculty members in the solid earth sciences (Assistant Professors and higher) showing whether or not they are now engaged in graduate work and showing inter alia complete publication lists, research funding in the past five years, and students and post-doctoral fellows supervised during their careers.

(ii) resources of space - a statement indicating the department's view of the adequacy of its space, and, in connection with the future plans in (d) below, discussing future space provision;

(iii) undergraduate base; honours students, number of qualifying or make-up year students, course enrolment, etc;

(iv) field budget for graduate work (for geography departments state total departmental amount and approximate fraction for solid earth sciences);

(v) support from related departments including shared teaching and research, state cross-appointments;

(vi) extent of major laboratory facilities and equipment available;

(vii) library resources: analysis of holdings and budget;

(viii) description of any inter-university arrangements for graduate work.

c) table of characteristics of graduate students in the department in previous five year, separately for master's and Ph.D., breaking down numbers by

(i) F.T. and P.T.;

(ii) immigration status (3 years), and country of first degree;

(iii) sources of financial support;

(iv) time to reach degree;

(v) drop-out number;

(vi) Ph.D. ABDs;

(vii) degrees granted;

(viii) post graduate employment of Ph.D.'s and ABD's (a) immediate and (b) after two years.

d) proposed plans for the future, in as much detail as the department can provide, including the proposed scheme for support of these plans, and accompanied by supporting arguments, including consideration of the sources of graduate students and an analysis of demand for graduates from the programmes. The various headings in a) and b) above should be dealt with quantitatively where possible; as a minimum, planned numbers of faculty and graduate students should be given.

B.2. The material so supplied will be collated by ACAP and transmitted to the discipline group for action indicated in paragraphs A.4., A.5 and A.6.

B.3. Apart from the material described in B.1.d and to some extent generated at the department level, each interested university will be requested to make an individual statement on its plans for the development of solid earth sciences, in particular the items of future commitment implied by item B.1.d. Deadline dates for parts A and B will be established by ACAP.

C. Terms of Reference of Consultants

C.1. Consider the materials prepared by the discipline group and the universities and obtain other data they may require to carry out the tasks detailed below. They may obtain data and views from any relevant source, such as, for example, employers of holders of graduate degrees, professional and learned societies, federal agencies. The campus of each interested university shall be visited by at least two consultants. Consultants shall arrange their schedule of visits to the universities in consultation with ACAP to ensure uniformity. Reports of appraisal consultants are privileged documents and are not to be made available to ACAP consultants. Consultants shall liaise with the discipline group near the beginning of the work, during the work as they consider necessary, and immediately before preparing their final report.

C.2. Report on the adequacy of the present state of graduate work in solid earth sciences in the province in general and in each university where applicable, discussing the following:

a. coverage of core elements and specialties, and extent of activity in each.

b. faculty quality and quantity

c. nature of programmes offered

d. enrolment size and distribution amongst universities

e. quality of student body; admission requirements

f. relationship to related disciplines, considering in particular the involvement of geology and geography students in training for work in oceanography, limnology, hydrogeology and glaciology

g. physical facilities

h. other matters considered by the consultants to be significant.

C.3. Make recommendations for the development of graduate work in solid earth sciences in Ontario between 1973 and 1983, but in more detail for 1973 through 1978, and, without limiting the generality of the foregoing, dealing with the following points:

a. Desirable programmes to be offered in the province, considering both possible limitations or reductions of existing programmes and creation of new programmes and new kinds of programmes including the appropriateness of part-time programmes. In particular, consider possible new fields in the solid earth sciences and training of students for work in application-oriented and inter-disciplinary work in which solid earth sciences should be involved.

b. Desirable provincial enrolments, year by year, in the various levels of graduate study, and specialties where appropriate. One should consider the need for highly trained manpower and also the general cultural and societal factors which may lead students to pursue graduate work in solid earth sciences. In considering manpower needs, one should take account of the "market" available to graduates (at least all of Canada) and of other sources of supply for that market. Results of forecasts of high level manpower employment should be treated with due caution and only in a clearly balanced relationship with cultural and societal needs.

c. Distribution amongst the universities of responsibility for programmes and for specialties where appropriate, including consideration of the need for any increase or decrease in the number of departments offering doctoral work and including consideration of areas of collaboration and sharing of facilities at regional level and across the province.

d. Distribution of enrolment amongst the universities, showing desirable ranges of enrolment.

e. Desirable extent of involvement with related disciplines, identifying any suggested areas for greater collaboration.

In all cases, it is important that the rationale for the recommendations be clear; this is especially important for items c. and d. Consultants are asked to comment on advantages and disadvantages of various techniques for arranging that their recommendations become effective.

C.4. It is permissible for consultants to recommend appraisals of individual programmes. This would arise if consultants were to suspect that a programme would be found to be wholly or in part below minimum acceptable standards; an appraisal by the Appraisals Committee is the means of settling the question. It is recognized that this action would be infrequent. Perhaps more likely, in planning assessments in some disciplines, consultants may find an excess of programmes in the same area of study, all of which could pass an appraisal; they would then have to make their own judgments of relative quality (a task outside the terms of reference of the Appraisals Committee), and guided by this judgment and other factors, the ACAP consultants would have to recommend where enrolment should be curtailed or eliminated.

D. Appointment of Consultants

The consultants shall include one person of wide academic experience in Canada but in a different discipline. The other three consultants shall be chosen so that their joint expertise covers adequately the various aspects of the solid earth sciences.

E. Report of Consultants

The consultants submit a joint report to ACAP. Minority reports are, of course, possible. The reasoning leading to their recommendations should be given fully, in view of the subsequent treatment of the report. The report is submitted for comment to the discipline group and to each interested university. There may be informal or interim exchanges of views amongst the discipline group, the universities, and ACAP. Any university which wishes to make a formal statement on the consultants' report shall submit it to ACAP. Any such report shall be transmitted to the discipline group. The discipline group shall submit its formal comments and/or recommendations to ACAP. ACAP considers the discipline group and university statements along with the consultants' report and trasmits them to COU with its recommendations of the position COU should adopt. Copies of the material transmitted to COU will be supplied to OCGS, to the Council of Deans of Arts and Science, and to the members of the discipline group and to the interested universities. The consultants' report may be published together with the comments of the discipline group, those of any university so requesting, and with the position adopted by COU.

A P P E N D I X E

DISCIPLINE GROUP MEMBERSHIP

GEOGRAPHY DISCIPLINE GROUP MEMBERSHIP

BROCK -	J. B. McClellan
CARLETON -	D. M. Anderson until May 1, 1972 J. P. Johnson
GUELPH -	F. A. Dahms
LAKEHEAD -	B. Phillips until April 26, 1973 D. Kemp
LAURENTIAN -	J. Konarek until March 1, 1972 A. A. Lupton
McMASTER -	* L. J. King until October 1, 1973 D. C. Ford
OTTAWA -	R. J. Wesche until June 22, 1973 H. Morrisette
QUEEN'S -	* R. H. T. Smith until August 1, 1972 R. I. Ruggles
TORONTO -	D. P. Kerr until February 14, 1973 J. Spelt
TRENT -	P. Adams
WATERLOO -	R. M. Irving until July 1, 1972 L. Russwurm
WATERLOO LUTHERAN -	J. McMurry
WESTERN ONTARIO -	W. Warntz
WINDSOR -	J. C. Ransome until February 7, 1972 M. Sanderson until July 1, 1972 F. C. Innes
YORK -	J. U. Marshall

*Chairman

GEOLOGY DISCIPLINE GROUP MEMBERSHIP

BROCK -	J. Terasmae
CARLETON -	J. M. Moore until January 10, 1972 W. M. Tupper
GUELPH -	W. Chesworth until February 1, 1973 D. E. Elrick
LAKEHEAD -	* E. Mercy
LAURENTIAN -	R. Cameron
McMASTER -	B. J. Burley until January 30, 1973 P. M. Clifford
OTTAWA -	D. D. Hogarth until January 10, 1972 A. J. Baer
QUEEN'S -	H. R. Wynne-Edwards until May 1, 1972 R. A. Price
TORONTO -	E. W. Nuffield until October 31, 1972 J. J. Fawcett R. M. Farquhar (Geophysics)
WATERLOO -	R. N. Farvolden
WESTERN ONTARIO -	A. E. Beck until July 30, 1973 W. S. Fyfe
WINDSOR -	P. Sonnenfeld
YORK -	H. I. Schiff until October 11, 1972 D. E. Smylie

*Chairman

A P P E N D I X F

ROLES OF ACAP AND OF DISCIPLINE GROUPS

Ontario Council on Graduate Studies

By-Law No. 3

A By-Law to establish a Committee on the Academic Planning of Graduate Studies.

1. The Ontario Council on Graduate Studies, recognizing the importance of providing for the continued and orderly development of graduate studies in the Ontario universities, establishes a Standing Committee to be known as the Advisory Committee on Academic Planning (abbreviation - ACAP).

Interpretation

2. In this By-Law,

   (a) "Committee" without further specification, means the Advisory Committee on Academic Planning;

   (b) "Council" or OCGS means the Ontario Council on Graduate Studies;

   (c) "Committee of Presidents" or CPUO means the Committee of Presidents of Universities of Ontario;

   (d) "university" means a provincially assisted university in Ontario;

   (e) "discipline" means any branch or combination of branches of learning so designated;

   (f) "discipline group" means a body designated as such by the Committee of Presidents of the Universities of Ontario, and normally consisting, for any one discipline, of one representative from each of the interested universities;

   (g) "planning assessment" means a formal review of current and projected graduate programmes within a discipline or a group of disciplines;

   (h) "programme" signifies all aspects of a particular graduate undertaking;

   (i) "rationalization" means the arranging of graduate programmes in order to avoid undesirable duplication, eliminate waste, and enhance and sustain quality.

Membership

3. (a) The Committee shall consist of at least seven members of the professoriate in Ontario universities, some of whom shall be members of the Council.

(b) The members of the Committee shall serve for such periods of time as the Council may determine, and they shall be selected in such manner as may provide for reasonable balance both of academic disciplines and of universities.

(c) The members of the Committee shall be appointed as individuals.

Chairman

4. The Chairman of the Committee shall be named by the Council, and he shall have one vote.

Quorum

5. A majority of all members of the Committee shall constitute a quorum.

Functions

6. The functions of the committee shall be

(a) To advise OCGS on steps to be taken to implement effective provincial planning of graduate development;

(b) To promote the rationalization of graduate studies within the universities, in cooperation with the discipline groups;

(c) To recommend, through OCGS, to CPUO the carrying out of planning assessments of disciplines or groups of disciplines and to recommend suitable arrangements and procedures for each assessment;

(d) To supervise the conduct of each planning assessment approved by CPUO;

(e) To respond to requests by CPUO to have a discipline assessment conducted by proposing suitable arrangements;

(f) To submit to CPUO the reports of the assessments together with any recommendations which the committee wishes to make. A copy of the report shall be sent to Council.

Jurisdiction

7. In order that the Committee may discharge the functions described in Section 6 above, it shall be authorized

   (a) to request a university to provide such information pertaining to graduate studies as may enable the Committee to discharge its functions;

   (b) to request a discipline group to provide such information as may enable the Committee to discharge its functions;

   (c) to receive reports from the universities and from the discipline groups, and to comment and communicate with the universities and the discipline groups concerning such reports;

   (d) to convene a meeting of any discipline group for the purpose of discussing the development to date, and proposals for the future development of graduate studies in the discipline concerned;

   (e) to send one or more representatives to a meeting of a discipline group at the invitation of the discipline group;

   (f) to make such suggestions to a discipline group as may be deemed appropriate to the functions of the Committee;

   (g) to supervise the conduct of planning assessments, and to report thereon to the Committee of Presidents of Universities of Ontario;

   (h) generally to report and to make recommendations to the Council;

   (i) to seek and receive advice from appropriate experts;

   (j) to employ consultants in connection with planning assessments.

Procedures

8. The procedure to be followed by the Committee shall be as approved by the Committee of Presidents of the University of Ontario.

9. The Committee's function is solely advisory.

Effective Date

10. This By-Law shall take effect January 1971.

ACAP DISCIPLINE GROUPS AND THEIR ROLES

1. Establishment of a Group

a. When it is considered desirable to activate planning of graduate work in some discipline(s) or interdisciplinary area, COU, on the advice of OCGS, will authorize the establishment of an ACAP discipline group, if it was not already approved and included in the May, 1968 list. If it is already authorized, ACAP may decide to set it up as described in paragraph b.

b. The Executive Vice-Chairman of ACAP will then invite the executive head of each university (including Waterloo Lutheran University) either to nominate a member of the discipline group or to indicate that his university has no plans for graduate study in this discipline in the next five years or so. If a university can state no plans for future graduate work in the subject, but feels that a watching brief is desirable, it may appoint an observer to the group.

c. Changes of a university's representative are to be notified by the executive head.

d. The group shall select its own chairman.

2. Meetings

a. A discipline group may meet at the call of its chairman or in accord with its own arrangements.

b. A discipline group may be called to meet by the Executive Vice-Chairman acting for ACAP.

3. Responsibilities

a. The group is to keep under review the plans for graduate work in its discipline in Ontario, including new developments and trends in the discipline, and to make reports to ACAP on a regular basis.

b. The group may make recommendations to ACAP in connection with graduate work in its discipline when it considers it appropriate.

c. ACAP will assist the group in obtaining information and data, as mutually agreed.

d. When COU has instructed ACAP to conduct a planning assessment, the discipline group will assist and advise ACAP in determining procedures and terms of reference, will report as requested and will generally facilitate the assessment.

Approved by OCGS March 22, 1973
and by COU April 6, 1973.

Note:

In a number of subjects, there exist committees of chairmen of departments, or councils of departments, or provincial associations of professors of a discipline or a specialty. It has sometimes been suggested that one of these organizations replace the corresponding discipline group. There are a number of reasons for preserving the distinction between discipline groups and these organizations with a wider range of responsibilities and the protocol given above was established by COU after consideration of these factors.

The main reasons for insisting on the distinction have to do with reporting channels, the variable and, in some cases, changing composition of these bodies, the fact that not all such organizations decide to include all the universities that would elect to be on a discipline group, and the fact that each member of a discipline group represents his university (not his department) and is appointed through the president. In some cases, the academic structure of some universities is such that more than one department is interested in the subject matter of a single discipline group.

It is thought that a major role in future planning activities will fall on the discipline groups and since it is hard to foresee exactly how the inter-university structures will be operating in a year or two, it is important to be particularly careful to insist on a well defined protocol for discipline groups. Of course, there may be advantages for some discipline groups to have close contacts with some council of this character, and occasionally to arrange to have that council perform some task on its behalf.

A P P E N D I X G

CURRICULA VITARUM OF THE CONSULTANTS

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Born Kenora, Ontario, January 5, 1927

B.Sc., Brandon College, 1950
M.A., Queen's, 1956
Ph.D., Princeton, 1958

University of Alberta, Assistant Professor, 1958-63
Associate Professor, 1963-65
University of Calgary, Professor of Geology, 1965-
Head of Department of Geology, 1965-70
Vice-President (Capital Resources), 1970-72
Vice-President (Academic), 1972-

Fellow, Royal Society of Canada

Honorary Fellow, Australian National University, 1967
Member, Mineralogical Association of Canada
Member, Mineralogical Society of America
Member, Association of Professional Engineers, Geologists and Geophysicists of Alberta
Member, Alberta Society of Petroleum Geology

Economic geology; mineralogy; petrology; geochemistry

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Born Edinburgh, Scotland, September 19, 1914

B.A., Oxford, 1937
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Ph.D., McGill, 1941

Canadian Acting Consul to Greenland, 1941-46
McGill University, Assistant Professor, 1946-48
Associate Professor, 1948-59
Professor of Zoology, 1959-
Marine Science Centre, Chairman, 1963-

Guggenheim Fellowship to Denmark, 1952-53
Senior Research Fellowship, Smithsonian Institute, 1969
Fellow, Royal Society of Canada
Fellow, Arctic Institute of North America
Chairman of the Board, 1954
Fellow, Royal Geographical Society
Honorary Fellow, American Geographical Society
Royal Society of Edinburgh, Bruce Memorial Medal for Polar Exploration, 1950
Fellow, Linnean Society, London

Chairman, Panel of the Marine Environment, National Academy of Sciences (US)

Marine biology and oceanography; arctic regions; breeding cycles in the arctic plankton; production in arctic water; development of arctic marine resources; history of biology

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Born Hellidon, Northants., England, September 11, 1916

B.A., London, 1937
M.A., London, 1944
Ph.D., London, 1951
D.Sc., London, 1971

Royal Air Force, 1940-46
Technical College, Enfield, Middlesex, Lecturer in Geography and Geology, 1946-48
University of London, Birkbeck College, Lecturer in Geography, 1949-62
US Geological Survey, Water Resources Division, Division Staff Scientist, 1960-61
University of Sydney (Australia), McCaughey Professor of Geography
and Head of Department, 1962-69
Dean, Faculty of Science, 1966-68
State University of Florida, Visiting Professor of Geology, 1967
University of Wisconsin, Professor of Geography and Geology, 1969-
Chairman, Department of Geography, 1971-

King's Scholarship, King's College, University of London, 1938-39
Honorary Life Member, Geographical Society of New South Wales, 1969

Member, Association of American Geographers
Member, Australian and New Zealand Association for the Advancement of Science
Member, Geological Society of London
Member, Geologists' Association
Member, Geographical Association
Member, Geographical Society of America
Member, Insitiute of Australian Geographers
Member, Institute of British Geographers
Member, Geological Society of Australia
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Member, Geological Society of America

Consulting/Advisory Editor for Geographical Analysis and Progress in Geography

Fluvial morphology; relict deep weathering; geomorphic impact of climatic change

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Born Toronto, Ontario, February 27, 1929

B.A., Toronto, 1951
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Ph.D., Toronto, 1954

University of Toronto, Lecturer, 1954-56
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University of British Columbia, Associate Professor of Physics, 1958-62
University of Toronto, Professor of Physics, 1962-63
University of British Columbia, Professor of Geophysics, 1963-
Head of Department of Geophysics and Astronomy, 1968-
Acting Director, Institute of Astronomy and Space Sciences, 1969-70

Sloane Foundation Inc. Fellowship, 1955-59
Killam Senior Fellow at the University of Tokyo, 1970-71
Fellow, Royal Society of Canada

Member, American Geographical Union
Member, Canadian Association of Physicists
Member, Geochemical Society
Member, B.C. Geophysical Society

NRC, Associate Committee of Geodesy and Geophysics, Member 1960-67, 1969-
Seismic Subcommittee, Member, 1966- ; Chairman, 1970-
Isotope Subcommittee, Chairman, 1960-67
Exploration Geophysics Subcommittee, Member, 1962-68
Upper Mantle Subcommittee, 1964-68
NRC, Grant Screening Committee of Earth Sciences, 1964-67
Arctic Institute of North America, Member of Seismology Advisory Committee, 1966-
Defence Research Board, Grant Screening Committee of Geophysics, 1968-72
Department of Energy, Mines and Resources, National Advisory Committee on Research in the Geological Sciences, Member, 1968-

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